

UFR Series NFC reader API reference

This document applies to Digital Logic's uFR Series readers only.

For more information, please visit <http://www.d-logic.net/nfc-rfid-reader-sdk/>

The scope of this document is to give a better insight and provide easy start with uFR Series NFC readers.

uFR Series readers communicate with host via built in FTDI's USB to Serial interface chip.

If you have uFR Series reader with RS232 interface, please refer to "[Communication protocol - uFR Series](#)" document at our download section.

We provide dynamic libraries for all major OS: Win x86, Win X86_64, Linux x86, Linux x86_64, Linux ARM (and ARM HF with hardware float) and Mac OS X.

Our dynamic libraries rely on FTDI D2XX direct drivers. Most of them are already built in at today's modern OS. However, we always suggest to perform clean driver installation procedure by downloading and installing drivers from FTDI's download webpage.

Android platform is supported through FTDI's Java D2XX driver. Since this approach introduces new Java class, it shall be a scope of separate document.

Important update:

From library version 4.01 and up, it is possible to establish communication with reader without using FTDI's D2XX driver by calling **ReaderOpenEx** function. Library can talk to reader via COM port (physical or virtual) without implementing FTDI's calls. However, this approach is not fast as with use of D2XX drivers but gives much more flexibility to users who had to use COM protocol only, now they can use whole API set of functions via COM port.

Library naming convention

Dynamic libraries names are built upon following convention:

- Library always have "uFCoder" in its name as mandatory
- Prefix "lib" according to platform demands
- Suffix with architecture description
- Extension according to platform demands

Our standard library pack contains following libraries:

- libuFCoder-arm.so – for Linux on ARM platforms with software float

- libuFCoder-armhf.so - for Linux on ARM platforms with hardware float
- libuFCoder-x86.so – for Linux on Intel 32 bit platforms
- libuFCoder-x86_64.so - for Linux on Intel 64 bit platforms
- uFCoder-x86.dll – for Windows 32 bit
- uFCoder-x86_64.dll – for Windows 64 bit
- libuFCoder.dylib – for all OS X Intel based versions

Update policy: we release updated firmware and libraries frequently, with minor & major updates, bug-fixes, new features etc. All libraries mentioned above are affected with each update. Updates are absolutely free and can be obtained from our download page at “Libraries” section, while firmware updates are available at “Firmware” section by using software tool specially designed for that purpose. Library update package always have the following directory structure:

- “include” - contains “uFCoder.h” header file
- “linux” – contains directories “arm”, “armhf”, “x86” with appropriate libraries
- “osx” – contains library for OSX
- “windows” – contains libraries for Windows

and appropriate README file with short description of current revision.

Some considerations regarding platform specifics

Because FTDI driver is mandatory, proper installation method must be followed. See [appendix for FTDI troubleshooting](#) for details.

Reader’s firmware and library functions relation

When you call library function, in most cases you are issuing protocol command to reader firmware. Library functions are usually wrapped firmware commands. This approach is very convenient for rapid application development and as time saving feature. Particularly, library function does the following:

- Check if all function parameters are proper
- Send corresponding firmware command to reader with parameters given
- Parses reader’s response as “out” parameters and function result

There are exceptions of this rule for certain type of functions. For firmware functions, please refer to [“Communication protocol - uFR Series”](#) document at our download section.

Multi reader support

There can be many uFR Series readers connected to a single host. Natively, all library functions are intended for use with “single reader” configuration.

All “single reader” functions have corresponding “multi reader” function. Multi reader functions differs from the “single” functions by following:

Multi-function name always have suffix “M” at the end of function name

First parameter of Multi-function is always “Handle”. For example,

```
SomeFunction(void) => SomeFunctionM(Handle)
```

```
OtherFunction(par1, par2) => OtherFunctionM(Handle, par1, par2)
```

More about Multi-function usage can be found in the [Handling with multiple readers](#).

Function syntax and data types in this document

By default, all functions are shown as their prototypes in C language.

All data types refers C types, except new defined “c_string” data type which representing null terminated char array (also known as “C-String”). Array is always one byte longer (for null character) then string. “c_string” is defined as

```
“typedef const char * c_string”.
```

For quick reference, always consult latest header file “uFCoder.h” at library package. Direct link to “uFCoder.h” can be found on the GIT repository: <https://www.d-logic.net/code/nfc-rfid-reader-sdk/ufr-lib/blob/master/include/uFCoder.h>

Error codes

All functions always have return result with corresponding status code. Please refer to table ERR_CODES in [Appendix: ERROR CODES \(DL_STATUS result\)](#).

In general you should always get function result = 0x00 if function is finished properly. One exception from this rule is if you get “0x08” – “NO_CARD” result. In a matter of fact, this is not an error, function is executed properly but there is no card present at readers RF field.

All other results indicates that some error occurred.

API set of functions

API set of functions is divided in three categories:

1. Common set
2. Advance set
3. Access control set

Common set of functions is shared among all uFR Series devices.

Advance set contains additional functions for use with uFR Advance and BASE HD uFR devices. It has additional functions for use of Real Time Clock (RTC) and user configurable EEPROM functions.

Access control set contains additional functions for use with BASE HD uFR devices. It has additional functions for use of I/O features like control of door lock, relay contacts and various inputs.

In further reading functions will be marked if they belong to Advance or Access control set.

Library functions

Functions are divided into several groups, based on purpose.

Reader and library related functions

Functions related to reader itself, to obtain some info or set certain device parameters.

Card/tag related commands

Functions used for card (or tag) data manipulation, such as obtaining some info, reading or writing data into card. Can be divided into several groups:

General purpose card related commands

Functions for getting common card data, not specific to card type.

Mifare Classic specific commands

Functions specific to Mifare Classic ® family of cards (Classic 1K and 4K). All functions are dedicated for use with Mifare Classic ® cards. However, some functions can be used with other card types, mostly in cases of direct addressing scheme and those functions will be highlighted in further text.

- a) Block manipulation commands – direct and indirect addressing

Functions for manipulating data in blocks of 16 byte according to Mifare Classic ® memory structure organization.

- b) Value Block manipulation commands – direct and indirect addressing

Functions for manipulating value blocks byte according to Mifare Classic ® memory structure organization.

c) Linear data manipulation commands

Functions for manipulating data of Mifare Classic ® memory structure as a Linear data space.

From firmware version 5.0.29. same functions may be used with Mifare Plus ® card in SL3 mode. In SL3 mode uses the AES keys, which calculated from Crypto 1 keys.

NFC – NDEF related commands

Functions for reading and writing common NDEF messages and records into various NFC tags. Currently, only NFC Type 2 Tags are supported, while support for other NFC Tag types will be added in future upgrades.

NTAG related commands

Functions specific to NTAG ® family chips such as NTAG 203, 210, 212, 213, 215, 216. Due to different memory size of various NTAG chips, we implemented functions for handling NTAG chips as generic NFC Type 2 Tag.

UID ASCII mirror support

NTAG 21x family offers specific feature named “UID ASCII mirror function” which is supported by the uFR API using the function `write_ndef_record_mirroring()`. For details about “UID ASCII mirror function” refer to http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 21) and http://www.nxp.com/docs/en/data-sheet/NTAG210_212.pdf (in Rev. 3.0 from 14. March 2013, page 16).

NFC counter mirror support

NTAG 213, 215 and 216 devices offers specific feature named “NFC counter mirror function” which is supported by the uFR API using the function `write_ndef_record_mirroring()`. For details about “NFC counter mirror function” refer to a document http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 23).

UID and NFC counter mirror support

NTAG 213, 215 and 216 devices offers specific feature named “UID and NFC counter mirror function” which is supported by the uFR API using the function `write_ndef_record_mirroring()`. For details about “NFC counter mirror function” refer to a document http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 26).

Mifare DESFire specific commands

Functions specific to Mifare DESFire® cards. All uFR Series readers support DESfire set of commands in AES encryption mode according to manufacturer's recommendations.

All readers have hardware built-in AES128 encryption mechanism. That feature provides fast and reliable results with DESFire cards without compromising security keys. Since DESFire EV1/EV2 cards comes in DES mode as factory default setting (due to backward compatibility with older DESfire cards), cards must be turned to AES mode first. There is library built in function for that purpose.

From library version 5.0.14 an firmware version 5.0.25. operations with DES, 2K3DES, 3K3DES, and AES keys supported.

Authentication and password verification protection

Mifare Classic ® family of cards uses authentication mechanism based on 6 bytes keys, which will be explained later in more detail.

NTAG ® 21x family chips and MIFARE Ultralight EV1 uses password verification protection based on PWD and PACK pairs which length is 6 bytes in total. PWD is 4 bytes in length and PACK is contained in 2 bytes. uFR API use this 6 bytes PWD/PACK pair (first goes 4 bytes of the PWD following by the 2 bytes of the PACK) to form PWD/PACK key which is used for password verification with those chip families in the similar manner as the authentication mechanism based on 6 bytes keys.

Selection of the authentication and password verification mechanisms, in the data manipulation functions, is based on the value of the **auth_mode** parameter.

For details about "Password verification protection" refer to following documents: http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 30), http://www.nxp.com/docs/en/data-sheet/NTAG210_212.pdf (in Rev. 3.0 from 14. March 2013, page 19) and <https://www.nxp.com/docs/en/data-sheet/MF0ULX1.pdf> (in Rev. 3.2 from 23. Nov 2017, page 16).

Specific firmware features

There are few firmware features which are specific to uFR Series readers.

Tag Emulation mode

In this mode, reader acts as a Tag. In that mode, not all library functions are available. Reader must be explicitly turned in or out of Tag Emulation mode. Maximum total size for emulated NDEF message is 144 bytes.

In further reading this topic will be covered in more details.

Combined mode

In combined mode, reader is switching from reader mode to Tag Emulation mode and vice verse few times in seconds. Reader must be explicitly turned in or out of Combined mode.

In further reading this topic will be covered in more details.

Asynchronous UID sending

This feature is turned off by default.

If turned on, it will send card UID as a row of characters on COM port at defined speed using following format:

```
[Prefix byte] UID_chars [Suffix byte]
```

Where Prefix byte is optional and Suffix byte is mandatory.

In further reading this topic will be covered in more details.

Sleep and Auto Sleep feature

Sleep feature is turned off by default. If turned on, it will put reader into special low power consumption mode to preserve power. In this mode, reader will respond only on function to “wake up”: turn sleep off.

Autosleep feature is different than previous in one major point: it will put reader into sleep after a predefined amount of time and will respond to function calls. Time can be adjusted with dedicated API function.

In further reading this topic will be covered in more details.

Card UID remarks

uFR Series readers support Card Unique Identifier (Card UID) with various byte length according to defined standards.

4 byte IDs: Non-unique IDs (NUID) are 4 byte long and as the name says, they are Non-Unique, so there is always possibility of existing two or more cards with the same ID (NUID).

7 byte IDs: Card UID are currently 7 byte long with never card types and still provide number range which large enough to provide uniqueness of IDs. These type of UIDs are fully supported at uFR series devices.

10 byte IDs: currently not in use but they are defined by standard for some future use. UFR Series devices are capable of handling this type of IDs when they become available.

Mifare Classic chips overview

One of the most popular and worldwide used contactless card type is NXP's Mifare Classic card, which comes in two memory map layouts: as 1K and 4K card.

Most of mentioned cards comes with 4 byte NUID. Cards with newer production date can be found with 7 byte UID too, especially MF1S70 type.

Mifare Classic 1K (MF1S50) and its derivatives has EEPROM with 1024 bytes storage, where 752 bytes are available for user data.

1 Kbyte EEPROM is organized in 16 sectors with 4 blocks each. A block contains 16 bytes. The last block of each sector is called “trailer”, which contains two secret keys (KeyA and KeyB) and programmable access conditions for each block in this sector.

Keys are encrypted with proprietary algorithm called “Crypto1”.

Figure 1 : MF1S50 memory map

| | | |
|--------------|--------------------|----------------------------|
| Sector 0 | Block 0 | Manufacturer Data |
| | Block 1 | DATA |
| | Block 2 | DATA |
| | Block 3 Trailer | Keys and Access Conditions |
| Sector 1 | Block 0 | DATA |
| | Block 1 | DATA |
| | Block 2 | DATA |
| | Block 3 Trailer | Keys and Access Conditions |
| ... | | |
| Sector 15 | Block 0 | DATA |
| | Block 1 | DATA |
| | Block 2 | DATA |
| | Block 3 Trailer | Keys and Access Conditions |

Mifare Classic 4K (MF1S70) and its derivatives has EEPROM with 4096 bytes storage, where 3440 bytes are available for user data.

4 Kbyte EEPROM is organized in 40 sectors with 4 blocks each. A block contains 16 bytes. The last block of each sector is called “trailer”, which contains two secret keys (KeyA and KeyB) and programmable access conditions for each block in this sector.

On the contrary of MF1S50, memory is organized in 32 sectors of 4 blocks (sectors 0 -31) and 8 sectors of 16 blocks (sectors 32 - 39).

Keys are encrypted with proprietary algorithm called “Crypto1”.

Figure 2 : MF1S70 memory map

| | | |
|--------------|---------------------|----------------------------|
| Sector 0 | Block 0 | Manufacturer Data |
| | Block 1 | DATA |
| | Block 2 | DATA |
| | Block 3 Trailer | Keys and Access Conditions |
| Sector 1 | Block 0 | DATA |
| | Block 1 | DATA |
| | Block 2 | DATA |
| | Block 3 Trailer | Keys and Access Conditions |
| ... | | |
| Sector 31 | Block 0 | DATA |
| | Block 1 | DATA |
| | Block 2 | DATA |
| | Block 3 Trailer | Keys and Access Conditions |
| Sector 32 | Block 0 | DATA |
| | Block 1 | DATA |
| | ... | DATA |
| | Block 15 Trailer | Keys and Access Conditions |
| ... | | |
| Sector 39 | Block 0 | DATA |
| | Block 1 | DATA |
| | ... | DATA |
| | Block 15 Trailer | Keys and Access Conditions |

Mifare Classic Keys and Access Conditions

Understanding memory map and access conditions of MF1S50 and MF1S70 cards is a must for proper data manipulation with mentioned cards.

Since that subject needs further reading and study, it is out of scope of this document.

Please refer to manufacturer's technical documents for further details. Documents are available at public access on the manufacturer's website.

Further reading of this document is not recommended before one get better insight and understanding of mentioned chip types.

We will try to give brief explanation of access bits and conditions. The next part of the text is taken from manufacturer's documentation "MF1ICS50 – Functional specification" available publicly [here](#).

Access conditions

The access conditions for every data block and sector trailer are defined by 3 bits, which are stored non-inverted and inverted in the sector trailer of the specified sector.

The access bits control the rights of memory access using the secret keys A and B. The access conditions may be altered, provided one knows the relevant key and the current access condition allows this operation.

Remark: With each memory access the internal logic verifies the format of the access conditions. If it detects a format violation the whole sector is irreversible blocked.

Remark: In the following description the access bits are mentioned in the non-inverted mode only.

The internal logic of the MF1ICS50 ensures that the commands are executed only after an authentication procedure or never.

Figure 1 Access conditions

| Access Bits | Valid Commands | Block | Description |
|------------------|--|-------|----------------|
| $C1_3 C2_3 C3_3$ | read, write | 3 | sector trailer |
| $C1_2 C2_2 C3_2$ | read, write, increment, decrement, transfer, restore | 2 | data block |
| $C1_1 C2_1 C3_1$ | read, write, increment, decrement, transfer, restore | 1 | data block |
| $C1_0 C2_0 C3_0$ | read, write, increment, decrement, transfer, restore | 0 | data block |

Figure 2 Organization of Access Bits

| Byte number | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|--------------|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---|---|-------|----|----|----|----|----|
| | Key A | | | | | | Access bits | | | | Key B | | | | | |
| | | | | | | | | | | | | | | | | |
| Bits | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | | | |
| Byte 6 | C2 ₃ | C2 ₂ | C2 ₁ | C2 ₀ | C1 ₃ | C1 ₂ | C1 ₁ | C1 ₀ | | | | | | | | |
| Byte 7 | C1 ₃ | C1 ₂ | C1 ₁ | C1 ₀ | C3 ₃ | C3 ₂ | C3 ₁ | C3 ₀ | | | | | | | | |
| Byte 8 | C3 ₃ | C3 ₂ | C3 ₁ | C3 ₀ | C2 ₃ | C2 ₂ | C2 ₁ | C2 ₀ | | | | | | | | |
| Byte (GPB) 9 | General Purpose Byte - USER data | | | | | | | | | | | | | | | |

Access conditions for the sector trailer

Depending on the access bits for the sector trailer (block 3) the read/write access to the keys and the access bits is specified as 'never', 'key A', 'key B' or key A|B' (key A or key B).

On chip delivery the access conditions for the sector trailers and key A are predefined as transport configuration. Since key B may be read in transport configuration, new cards must be authenticated with key A. Since the access bits themselves can also be blocked, special care should be taken during personalization of cards.

Figure 3 Access conditions for the sector trailer

| Access value arg. | Access bits | | | Access condition for | | | | | | Remark |
|-------------------|-----------------|-----------------|-----------------|----------------------|-------|-------------|-------|-------|-------|---|
| | | | | KEYA | | Access bits | | KEYB | | |
| | C1 ₃ | C2 ₃ | C3 ₃ | read | write | read | write | read | write | |
| 0 | 0 | 0 | 0 | never | key A | key A | never | key A | key A | Key B may be read ^[1] |
| 2 | 0 | 1 | 0 | never | never | key A | never | key A | never | Key B may be read ^[1] |
| 4 | 1 | 0 | 0 | never | key B | key A B | never | never | key B | |
| 6 | 1 | 1 | 0 | never | never | key A B | never | never | never | |
| 1 | 0 | 0 | 1 | never | key A | key A | key A | key A | key A | Key B may be read, transport configuration ^[1] |
| 3 | 0 | 1 | 1 | never | key B | key A B | key B | never | key B | |
| 5 | 1 | 0 | 1 | never | never | key A B | key B | never | never | |
| 7 | 1 | 1 | 1 | never | never | key A B | never | never | never | |

^[1] Remark: the grey marked lines are access conditions where key B is readable and may be used for data.

Access conditions for data blocks

Depending on the access bits for data blocks (blocks 0...2) the read/write access is specified as 'never', 'key A', 'key B' or 'key A|B' (key A or key B). The setting of the relevant access bits defines the application and the corresponding applicable commands.

- Read/write block: The operations read and write are allowed.
- Value block: Allows the additional value operations increment, decrement, transfer and restore. In one case ('001') only read and decrement are possible for a non-rechargeable card. In the other case ('110') recharging is possible by using key B.
- Manufacturer block: The read-only condition is not affected by the access bits setting!

Figure 4 Access conditions for data blocks

| Access value (to the function) | Access bits | | | Access condition for | | | | Application |
|-----------------------------------|-------------|----|----|----------------------|----------------------|----------------------|------------------------------------|-------------------------|
| | C1 | C2 | C3 | read | write | increment | decrement, transfer, restore | |
| 0 | 0 | 0 | 0 | key A B ¹ | key A B ¹ | key A B ¹ | key A B ¹ | transport configuration |
| 2 | 0 | 1 | 0 | key A B ¹ | never | never | never | read/write block |
| 4 | 1 | 0 | 0 | key A B ¹ | key B ¹ | never | never | read/write block |
| 6 | 1 | 1 | 0 | key A B ¹ | key B ¹ | key B ¹ | key A B ¹ | value block |
| 1 | 0 | 0 | 1 | key A B ¹ | never | never | key A B ¹ | value block |
| 3 | 0 | 1 | 1 | key B ¹ | key B ¹ | never | never | read/write block |
| 5 | 1 | 0 | 1 | key B ¹ | never | never | never | read/write block |
| 7 | 1 | 1 | 1 | never | never | never | never | read/write block |

- Key management: In transport configuration key A must be used for authentication¹

¹If Key B may be read in the corresponding Sector Trailer it can't serve for authentication (all grey marked lines in previous table). Consequences: If the RDW tries to authenticate any block of a sector with key B using grey marked access conditions, the card will refuse any subsequent access after authentication.

Reader keys

All uFR Series devices has reserved nonvolatile memory space where following keys are stored:

- 32 Mifare Classic authentication keys, each 6 byte long, indexed [0-31]
- 16 AES keys for use with DESFire and Mifare Plus cards, each 16 bytes long, indexed [0-15]

All Mifare Classic keys have factory default value as 6 bytes of 0xFF.

All DESfire keys have factory default value as 16 bytes of 0x00.

Important Note: Keys are stored in reader using one way function and protected with password. Keys can be changed with appropriate credentials but can't be read in any circumstances. Please bear this in mind when handling key values.

Mifare Classic authentication modes and usage of keys

There are four possible ways of using Mifare keys when authenticating to card and they are named as follows:

- Reader Keys mode (RK) - default
- Automatic Key Mode 1 (AKM1)
- Automatic Key Mode 2 (AKM2)
- Provided Key mode (PK)

All Mifare Classic related functions have basic function name for default authentication method (RK) and three other variations with appended suffixes AKM1, AKM2 or PK. In further reading we will explain each basic function with variations of key mode usage.

All Mifare keys can be used as "Key A" or "Key B" as defined in Mifare Classic technical document.

For that purpose, each function which use authentication with keys also have parameter "AuthMode" which defines if particular key is used as "Key A" or "Key B".

In uFR Series API there are two constants defined for this case :

`MIFARE_AUTHENT1A = 0x60` - actual key is used as "Key A"

`MIFARE_AUTHENT1B = 0x61` - actual key is used as "Key B"

For Mifare Plus cards in SL1 mode uses same authentication modes.

For Mifare Plus cards in SL3 mode uses these authentication modes, and

`MIFARE_PLUS_AES_AUTHENT1A = 0x80`

`MIFARE_PLUS_AES_AUTHENT1B = 0x81`

Reader Keys mode (RK)

When using this authentication mode, keys stored in reader's memory are used for authentication to Mifare card. Reader Key index [0..31] is passed as function argument.

Example:

Reader keys are all set to default value 6 bytes of 0xFF. We want to use key "A0 A1 A2 A3 A4 A5h" as key A to authenticate to card.

First this key must be stored into reader's NVRAM at certain index, for example index=3.

Next, we use "SomeFunction" to do something with card where authentication is must and key is "A0 A1 A2 A3 A4 A5h". We will call "SomeFunction" with KeyIndex = 3 and AuthMode = "MIFARE_AUTHENT1A".

In this way authentication key is not exposed during communication with host.

Mifare Plus card using.

From firmware versions 5.0.1. to 5.0.28, and library versions to 5.0.18, AES keys read from reader memory, and key index is 0 to 15.

From firmware versions 5.0.29, and library version from 5.0.19. for authentication modes MIFARE_AUTHENT1A and MIFARE_AUTHENT1B, AES keys calculated from Crypto1 keys read from Crypto1 key space (index 0 - 31), and for authentication modes MIFARE_PLUS_AES_AUTHENT1A and MIFARE_PLUS_AES_AUTHENT1B, AES keys read from AES keys space (index 0 - 15).

Automatic Key Mode 1 (AKM1)

This mode is also using keys stored at reader's memory. Difference between this mode and RK is that keys are used at predefined order.

In this mode, keys indexed from [0..15] are used as "Key A" for each corresponding sector while keys indexed from [16..31] are used as "Key B" for each corresponding sector. That means Key A for Sector 0 is Key indexed as [0] etc.

Brief example:

Sector 0 : Key A = Key [0], Key B = Key [16]

Sector 1 : Key A = Key [1], Key B = Key [17]

Sector 2 : Key A = Key [2], Key B = Key [18]

Sector 3 : Key A = Key [3], Key B = Key [19]
...
Sector 15 : Key A = Key [15], Key B = Key [31]

Mifare Plus card using.

For firmware versions from 5.0.1. to 5.0.28 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B mode, and from firmware version 5.0.29 and library version from 5.0.19 in MIFARE_PLUS_AES_AUTHENT1A and MIFARE_PLUS_AES_AUTHENT1B mode, uses AES keys from AES keys space (index 0 - 15). In this mode, keys indexed from [0..7] are used as “Key A” for each corresponding sector while keys indexed from [8..15] are used as “Key B” for each corresponding sector.

Sector 0 : Key A = Key [0], Key B = Key [8]
Sector 1 : Key A = Key [1], Key B = Key [9]
Sector 2 : Key A = Key [2], Key B = Key [10]
Sector 3 : Key A = Key [3], Key B = Key [11]
...
Sector 7 : Key A = Key [7], Key B = Key [15]
Sector 8 : Key A = Key [0], Key B = Key [8]
...
Sector 15 : Key A = Key [7], Key B = Key [15]
Sector 16 : Key A = Key [0], Key B = Key [8]
...
Sector 23 : Key A = Key [7], Key B = Key [15]
Sector 24 : Key A = Key [0], Key B = Key [8]
...
Sector 31 : Key A = Key [7], Key B = Key [15]
Sector 32 : Key A = Key [0], Key B = Key [8]
...
Sector 39 : Key A = Key [7], Key B = Key [15]

For firmware versions from 5.0.29 and library versions from 5.0.19 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B, uses AES keys calculated from Crypto1 keys from Crypto1 keys space (index - 31). Keys uses in same manner as for Mifare Classic card.

Automatic Key Mode 2 (AKM2)

This mode is also using keys stored at reader's memory. Difference is that keys are used at predefined order as even and odd keys.

In this mode, keys indexed with even numbers {0,2,4...30} are used as “Key A” for each corresponding sector while keys indexed with odd numbers {1,3,5...31} are used as “Key B” for each corresponding sector.

Brief example:

```
Sector 0 : Key A = Key [0], Key B = Key [1]
Sector 1 : Key A = Key [2], Key B = Key [3]
Sector 2 : Key A = Key [4], Key B = Key [5]
Sector 3 : Key A = Key [6], Key B = Key [7]
...
Sector 15 : Key A = Key [30], Key B = Key [31]
```

Mifare Plus card using.

For firmware versions from 5.0.1. to 5.0.28 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B mode, and from firmware version 5.0.29 and library version from 5.0.19 in MIFARE_PLUS_AES_AUTHENT1A and MIFARE_PLUS_AES_AUTHENT1B mode, uses AES keys from AES keys space (index 0 - 15). In this mode, keys indexed with even numbers {0,2,4...14} are used as "Key A" for each corresponding sector while keys indexed with odd numbers {1,3,5..15} are used as "Key B" for each corresponding sector.

```
Sector 0 : Key A = Key [0], Key B = Key [1]
Sector 1 : Key A = Key [2], Key B = Key [3]
Sector 2 : Key A = Key [4], Key B = Key [5]
Sector 3 : Key A = Key [6], Key B = Key [7]
...
Sector 7 : Key A = Key [14], Key B = Key [15]
Sector 8 : Key A = Key [0], Key B = Key [1]
...
Sector 15 : Key A = Key [14], Key B = Key [15]
Sector 16 : Key A = Key [0], Key B = Key [1]
...
Sector 23 : Key A = Key [14], Key B = Key [15]
Sector 24 : Key A = Key [0], Key B = Key [1]
...
Sector 31 : Key A = Key [14], Key B = Key [15]
Sector 32 : Key A = Key [0], Key B = Key [1]
...
Sector 39 : Key A = Key [14], Key B = Key [15]
```

For firmware versions from 5.0.29 and library versions from 5.0.19 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B, uses AES keys calculated from Crypto1 keys from Crypto1 keys space (index - 31). Keys uses in same manner as for Mifare Classic card.

NOTE: In all three above mentioned modes, when using Mifare Classic 4K cards, there are some trade off.

Mifare Classic 4K have 40 sectors instead of 16 as Mifare Classic 1K. In such case, Key A for Sector 0 is the same as Key A for Sector 16 etc. For the last 8 sectors (sectors 32 to 39) the same readers keys are used that correspond to sectors 0 to 7 and 16 to 23.

Example:

```
Sector 16 : Key A, Key B = Sector [0]  keys
Sector 17 : Key A, Key B = Sector [1]  keys
Sector 18 : Key A, Key B = Sector [2]  keys
Sector 31 : Key A, Key B = Sector [15] keys
...
Sector 32 : Key A, Key B = Sector [0]  keys
Sector 33 : Key A, Key B = Sector [1]  keys
...
Sector 39 : Key A, Key B = Sector [7]  keys
```

Provided Key mode (PK)

In this case keys stored into reader are not in use. Key is passed as function parameter as it's real value, like a pointer to array of bytes : "A0 A1 A2 A3 A4 A5h".

For example, we will call "SomeFunction" with parameters "Key" and "AuthMode", where "Key" is a pointer to byte array which contains key value bytes.

This method is convenient for testing but we strongly discourage use of this method in real production environments, since keys is exposed on "wire" during communication with host.

Mifare Plus card using.

For MIFARE_PLUS_AES_AUTHENT1A and MIFARE_PLUS_AES_AUTHENT1B mode, 16 bytes AES key provided to reader.

For firmware version from 5.0.29 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B, used AES key calculated from 6 bytes Crypto1 key which provided to reader.

Other supported cad/tag types

Currently supported card/tag types in latest firmware revision are:

- Mifare Classic (and derivatives like Fudan FM11RF08)
- Infineon SLE66R35
- Mifare Ultralight (directly supported NFC Type2 Tag)
- Mifare Ultralight C (directly supported NFC Type2 Tag)
- NTAG 203, 210, 212, 213, 215, 216 (directly supported NFC Type2 Tag)
- Mikron MIK640D (directly supported NFC Type2 Tag)
- Other NFC Type2 Tag compatible card are supported as 'T2T generic type', calling **GetNfcT2tVersion()** gives more data about tag.

- Mifare Plus (in Mifare Classic compatibility mode SL1 and SL3 from library version 4.3.13 and uFR PLUS devices)
- Mifare DESFire EV1 (AES key, and other keys DES, 2K3DES, 3K3DES from library version 5.0.14 and firmware version 5.0.25)
- Mifare DESFire EV2 (in EV1 compatibility mode)

Future firmware and library releases will support additional currently missing features and card types.

API - Programming reference

Scope of this section is to show basic usage scenarios of uFR Series API library functions.

For code snippets and source code examples, please refer to “SDK” section at our download web page.

Most examples are written in various programming languages including C/C++, C#.NET, C++ .NET, VB.NET, Java, JavaScript, Python, Lazarus/Delphi.

Dynamic libraries are a part of source code example zip archives. Some libraries may be obsolete due to time of writing of example.

Please be sure to always use the latest library revision from “Libraries” section at our download web page.

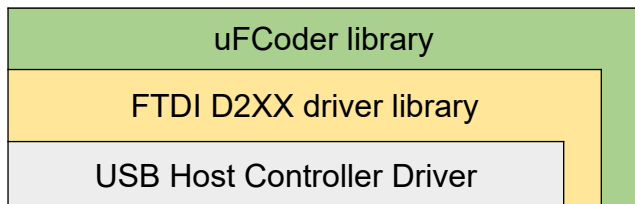
Simply replace obsolete libraries with latest library revision to explore all features mentioned in this document.

Communication and command flow

Communication with uFR Series reader ('reader' in further text) is established via USB physical communication link.

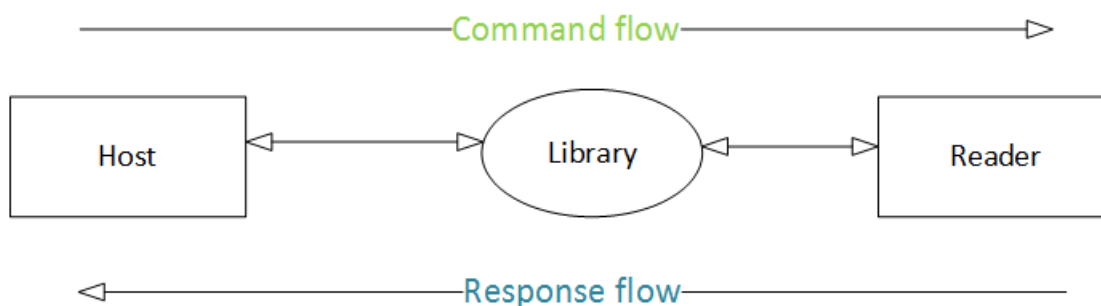
On top physical USB layer is FTDI's direct access through D2XX drivers library.

uFR Series dynamic library ('uFCoder library' in further reading) is placed above D2XX library.



uFR Series device and host are in master-slave relation, where host represents master and device is a slave.

Command flow is always initiated from master to slave and device is only responding to commands.



The following sections will describe single reader usage, meaning that only one reader is connected to host.

Connecting several readers to single host is possible and shall be described in separate section.

Important update:

From library version 4.01 and up, it is possible to establish communication with reader without using FTDI's D2XX driver by calling **ReaderOpenEx** function. Library can talk to reader via COM port (physical or virtual) without implementing FTDI's calls. However, this approach is not fast as

with use of D2XX drivers but gives much more flexibility to users who had to use COM protocol only, now they can use whole API set of functions via COM port.

| |
|--------------------------------|
| uFCoder library |
| COM port (physical or virtual) |

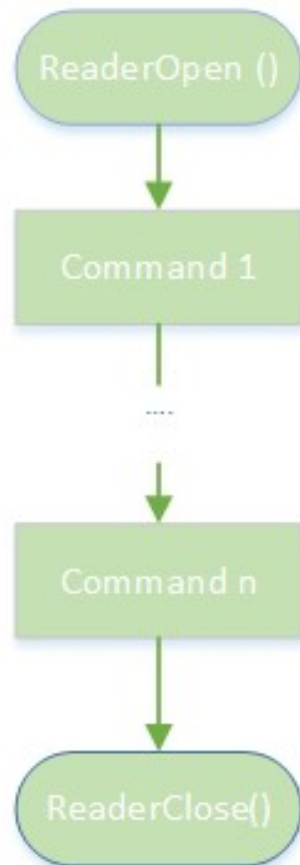
Program flow – basic usage

To establish communication with reader, there must be no other processes to disturbing this communication, which means that only one process or application can have open communication link with reader.

To establish communication link, ReaderOpen () command must be sent.

After successful link opening, all other library functions can be used.

At the end of use, link must be closed by ReaderClose () command, which is usually at application exit or process end.

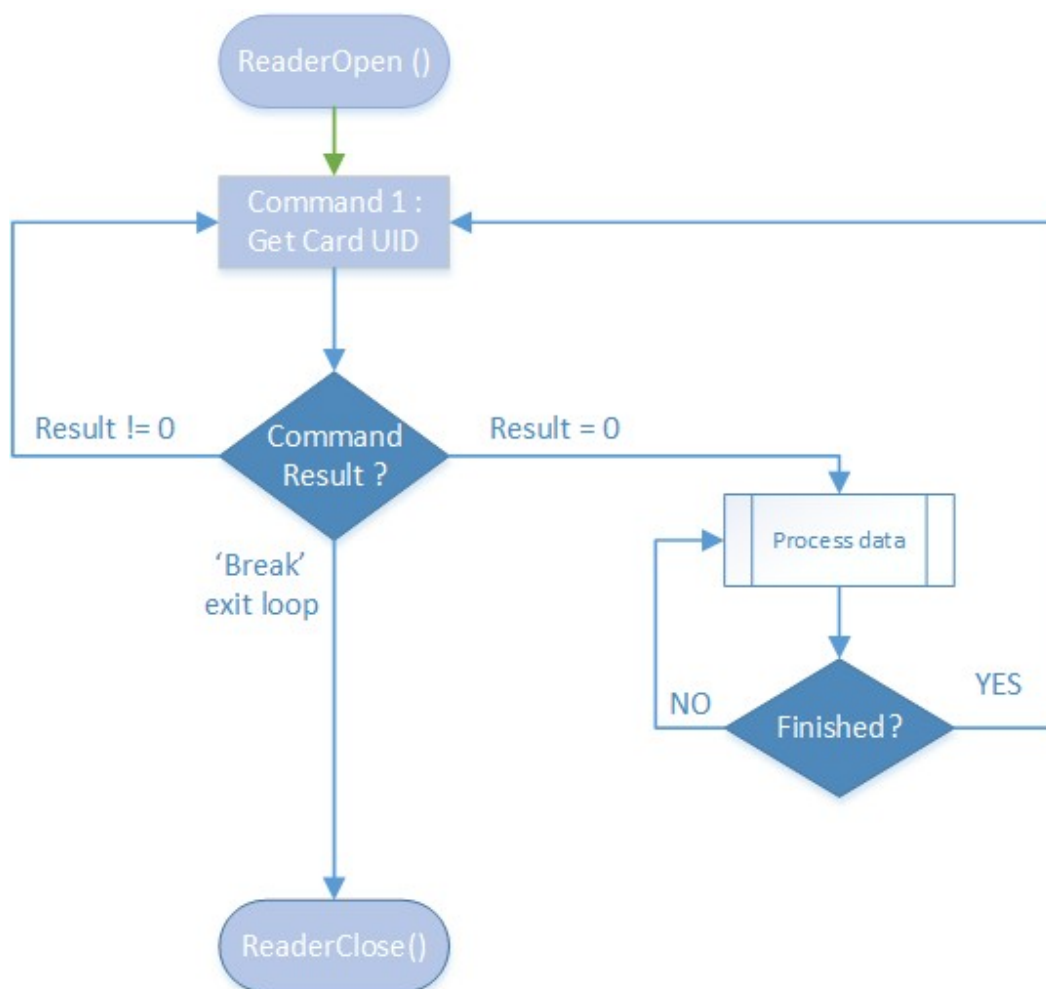


Program flow – polling

In many cases, there is a need to constantly examine some state or check for some events, like for card presence or similar. That is also known as “Polling Loop”.

In polling loop check is performed several times in second and number of check may vary. However, good practice is not to exceed 10 - 15 checks per second.

Almost all uFCoder library functions return Zero value if function call was successful and error code if not.



API - descriptions

Reader and library related functions

As mentioned earlier, uFCoder function call returns (in most cases) integer value as result of function operation. For possible values please refer to table ERR_CODES in [Appendix: ERROR CODES \(DL_STATUS result\)](#).

Exception from this rule are some functions with return parameters “c_string” which is a pointer to array of char (“*typedef const char * c_string*”).

Here is a list of reader and library related functions with return types:

| Reader and library functions | |
|------------------------------|----------------------------|
| Return Type | Function name |
| UFR_STATUS | ReaderOpen |
| UFR_STATUS | ReaderOpenEx |
| UFR_STATUS | ReaderOpen_uFROnline |
| UFR_STATUS | ReaderReset |
| UFR_STATUS | ReaderClose |
| UFR_STATUS | ReaderStillConnected |
| UFR_STATUS | GetReaderType |
| UFR_STATUS | GetReaderSerialNumber |
| UFR_STATUS | GetReaderHardwareVersion |
| UFR_STATUS | GetReaderFirmwareVersion |
| UFR_STATUS | GetBuildNumber |
| UFR_STATUS | GetReaderSerialDescription |
| UFR_STATUS | ChangeReaderPassword |
| UFR_STATUS | ReaderKeyWrite |
| UFR_STATUS | ReaderKeysLock |
| UFR_STATUS | ReaderKeysUnlock |
| UFR_STATUS | ReadUserData |
| UFR_STATUS | WriteUserData |
| UFR_STATUS | UfrEnterSleepMode |
| UFR_STATUS | UfrLeaveSleepMode |
| UFR_STATUS | AutoSleepSet |
| UFR_STATUS | AutoSleepGet |
| UFR_STATUS | SetSpeedPermanently |
| UFR_STATUS | GetSpeedParameters |
| UFR_STATUS | SetAsyncCardIdSendConfig |
| UFR_STATUS | GetAsyncCardIdSendConfig |
| UFR_STATUS | ReaderUISignal |
| UFR_STATUS | UfrRedLightControl |
| UFR_STATUS | SetDisplayData** |
| UFR_STATUS | SetDisplayIntensity** |
| UFR_STATUS | GetDisplayIntensity** |
| UFR_STATUS | SetSpeakerFrequency |
| uint32_t | GetDllVersion |
| c_string | GetDllVersionStr |
| c_string | UFR_STATUS2String |
| c_string | GetReaderDescription |

** - RFU(reserved for future use)

ReaderOpen

Function description

Open reader communication port for all μ FR devices. You can also use this function to open communication with μ FR Online devices.

Using ReaderOpen to open communication with μ FR Online devices:

If you have only one reader attached to your PC, it will open that reader serial port on 1Mbit/s, or if you have only one reader attached to another power supply (not your PC) it will open that reader based on it's working mode (TCP or UDP). If you have more than one μ FR Online device, ReaderOpen function will open the first one found, for opening another device, use ReaderOpenEx instead.

Function declaration (C language)

`UFR_STATUS ReaderOpen(void)`

No parameters required.

ReaderOpenByType

Function description

Opens a port of connected reader using readers family type. Useful for speed up opening for non μ FR basic reader type (e.g. BaseHD with μ FR support). Do not use this function for opening communication with μ FR Online devices.

Function declaration (C language)

`UFR_STATUS ReaderOpenByType(uint32_t reader_type) ;`

Parameters

- 0 - auto, same as call ReaderOpen()
- 1 - μ FR type (1 Mbps)
- 2 - μ FR RS232 type (115200 bps)
- 3 - BASE HD μ FR type (250 Kbps)

ReaderOpenEx

Function

description

Open reader communication port in several different ways. Can be used for establishing communication with COM port too. There is enumeration in uFCoder.h file called E_READER_TYPE with values:

```
enum E_READER_TYPE
{
    AUTO = 0,
    UFR_TYPE = 1,
    UFR_RS232_TYPE = 2,
    BASEHD_UFR_TYPE = 3,
    UFR_ONLINE_TYPE = 4
};
```

Values in this enumeration you can pass into ReaderOpenEx function as `reader_type` parameter.

For example, if you pass 4 as `reader_type` it will only work with μ FR Online Series devices, and then as `port_name` you can pass devices IP address or serial number (ex: "192.168.1.123" or "ON101390"), for `port_interface` you can pass 'U' for UDP, 'T' for TCP or 0. If you pass 0, it will automatically search for reader working mode (UDP or TCP) and open it. For argument you can pass 0 or μ FR Nano device serial number to open it on 1Mbit/s (ex: "UN123456").

Examples:

| | |
|-------------------------------------|---|
| ReaderOpenEx(1, "COM1", 0, 0) | This example will open communication with μ FR device attached to COM1 port on 1Mbit/s |
| ReaderOpenEx(1, 0, 0, 0) | This example will automatically find COM port and open communication with first μ FR device on 1Mbit/s |
| ReaderOpenEx(2, 0, 0, 0) | This example will automatically find COM port and open communication with first μ FR RS232 device on 115200 bit/s |
| ReaderOpenEx(4, "ON123456", 'U', 0) | This example will open communication with μ FR Online reader with serial number ON123456 on UDP protocol. |
| ReaderOpenEx(4, "ON123456", 'T', 0) | This example will open communication with μ FR Online reader with serial number |

| | |
|---|---|
| | ON123456 on TCP protocol. |
| ReaderOpenEx(4, "192.168.1.123", 'U', 0) | This example will open communication with μ FR Online reader with IP address 192.168.1.123 on UDP protocol. |
| ReaderOpenEx(4, "192.168.1.123", 'T', 0) | This will open communication with μ FR Online reader with IP address 192.168.1.123 on TCP protocol. |
| ReaderOpenEx(4, "192.168.1.123", 0, 0) | It will open communication with μ FR Online reader with IP address 192.168.1.123 based on its working protocol (UDP or TCP), because we passed 0 as <code>port_interface</code> |
| ReaderOpenEx(4, "ON123456", 0, 0) | It will open communication with μ FR Online reader with serial number ON123456 based on its working protocol (UDP or TCP), because we passed 0 as <code>port_interface</code> |
| ReaderOpenEx(4, "ON123456", 0, "UN654321") | It will open communication with μ FR Nano reader on 1Mbit/s with serial number UN654321 which is attached to μ FR Online device with serial number ON123456 |
| ReaderOpenEx(4, "192.168.1.123", 0, "UN654321") | It will open communication with μ FR Nano reader on 1Mbit/s with serial number UN654321 which is attached to μ FR Online device with IP address 192.168.1.123 |

Function declaration (C language)

```
UFR_STATUS ReaderOpenEx(uint32_t reader_type,  
                        c_string port_name,  
                        uint32_t port_interface,  
                        void *arg);
```

Parameters

| | |
|-----------------------|--|
| reader_type | <p>0 : auto - same as call ReaderOpen() 1 : uFR type (1 Mbps) 2 : uFR RS232 type (115200 bps) 3 : BASE HD uFR type (250 Kbps)</p> <p>When uFR Online reader works in Bluetooth mode or transparent mode, reader_type must be set to 2.</p> |
| port_name | <p>is c-string type used to open port by given serial name. If provide NULL or empty string that is AUTO MODE which calls ReaderOpenEx() and test all available ports on the system.</p> <p>serial port name, identifier, like "COM3" on Windows or "/dev/ttyS0" on Linux or "/dev/tty.serial1" on OS X or if you select FTDI, reader serial number like "UN123456", if reader have integrated FTDI interface</p> <p>When UDP interface type is selected, port_name must be provided in "address:port" format. Like "192.168.1.168:8881" IP for UDP I/F</p> |
| port_interface | <p>type of communication interfaces (define interface which we use while connecting to the printer), supported value's:</p> <p>0 : auto - first try FTDI than serial if port_name is not defined 1 : try serial / virtual COM port / interfaces 2 : try only FTDI communication interfaces 10 : try to open Digital Logic Shields with RS232 uFReader on Raspberry Pi (serial interfaces with GPIO reset) 84 ('T') : TCP/IP interface 85 ('U') : UDP interface 102 ('B') : Bluetooth serial interface. Android library only. 114 ('L') : Bluetooth Low Energy interface. Android library only.</p> <p>When uFR Online reader works in Bluetooth mode, port_interface must be set to 0 (Except Android).</p> |
| arg | <p>C-string with additional settings delimited with new lines. Settings C-string constant:</p> <p>"UNIT_OPEN_RESET_DISABLE" : do not reset the reader when opening "UNIT_OPEN_RESET_FORCE" : force reset the reader when opening</p> <p>"READER_ACTIVE_ON_RTS_LOW" : (default) Reset the reader when RTS is high - the reader works when RTS is low "READER_ACTIVE_ON_RTS_HIGH" : Reset the reader when RTS is low - the reader works when RTS is high "RTS_ALWAYS_HIGH" : not implemented yet</p> |

| | |
|--|---|
| | <p>"RTS_ALWAYS_LOW" : not implemented yet</p> <p>"RTS_DISCONNECTED" : disconnect RTS (RTS is not initiate nor use)</p> <p>When uFR Online reader works in Bluetooth mode or transparent mode, arg must be set to "UNIT_OPEN_RESET_DISABLE".</p> <p>Custom baud rates from library version 5.0.28. For all RS232 devices and USB devices from firmware version 5.0.31</p> <p>"BR_1000000" : 1 Mbps</p> <p>"BR_115200" : 115200 bps</p> <p>"BR_250000" : 250000 bps</p> <p>"BR_9600" : 9600 bps</p> <p>"BR_19200" : 19200 bps</p> <p>"BR_38400" : 38400 bps</p> <p>"BR_57600" : 57600 bps</p> <p>"BR_230400" : 234000 bps</p> <p>"BR_460800" : 460800 bps</p> <p>"BR_500000" : 500000 bps</p> |
|--|---|

ReaderOpen_uFROnline

Function

description

Opens uFR Online device by serial number. Function will open communication (UDP or TCP) with device based on its working mode. If function cannot find given serial number, it will open communication on serial port with 1Mbit/s.

Function declaration (C language)

```
UFR_STATUS ReaderOpen_uFROnline(c_string serial_number)
```

Parameter

| | |
|----------------------|---|
| serial_number | Pointer to const char array (c_string) containing devices serial number (ex. "ON101390"). |
|----------------------|---|

ReaderReset

Function

description

Physical reset of reader communication port.

Function declaration (C language)

UFR_STATUS ReaderReset(void)

No parameters required.

ReaderClose

Function description

Close reader communication port.

Function declaration (C language)

UFR_STATUS ReaderClose(void)

No parameters required.

ReaderStillConnected

Function description

Retrieve info if reader is still connected to host.

Function declaration (C language)

UFR_STATUS ReaderStillConnected(uint32_t *connected)

Parameter

| | | |
|--|--|---|
| connected | pointer to <code>connected</code> variable | |
| | “connected” as result: | |
| | > 0 | Reader is connected on system |
| | = 0 | Reader is not connected on system anymore (or closed) |
| | < 0 | other error |
| “connected” - Pointer to unsigned int type variable 32 bit long, where the information about readers availability is written. If the reader is connected on system, function store 1 (true) otherwise, on some error, store zero in that variable. | | |

GetReaderType

Function description

Returns reader type as a pointer to 4 byte value.

Function declaration (C language)

UFR_STATUS GetReaderType (uint32_t *lpulReaderType)

Parameter

| | |
|-----------------------|---|
| lpulReaderType | pointer to lpulReaderType variable. "lpulReaderType" as result – please refer to Appendix: DLogic reader type enumeration . E.g. for µFR Nano Classic readers this value is 0xD1180022. |
|-----------------------|---|

GetReaderSerialNumber

Function description

Returns reader serial number as a pointer to 4 byte value.

Function declaration (C language)

UFR_STATUS GetReaderSerialNumber (uint32_t *lpulSerialNumber)

Parameter

| | |
|-------------------------|---|
| lpulSerialNumber | pointer to lpulSerialNumber variable. "lpulSerialNumber" as result holds 4 byte serial number value. |
|-------------------------|---|

GetReaderHardwareVersion

Function description

Returns reader hardware version as two byte representation of higher and lower byte.

Function declaration (C language)

**UFR_STATUS GetReaderHardwareVersion (uint8_t *version_major,
uint8_t *version_minor);**

Parameters

| | |
|----------------------|-----------------------------------|
| version_major | pointer to version major variable |
| version_minor | pointer to version minor variable |

GetReaderFirmwareVersion

Function description

Returns reader firmware version as two byte representation of higher and lower byte.

Function declaration (C language)

```
UFR_STATUS GetReaderFirmwareVersion(uint8_t *version_major,
                                     uint8_t *version_minor);
```

Parameters

| | |
|----------------------------|-----------------------------------|
| <code>version_major</code> | pointer to version major variable |
| <code>version_minor</code> | pointer to version minor variable |

GetBuildNumber**Function description**

Returns reader firmware build version as one byte representation.

Function declaration (C language)

```
UFR_STATUS GetBuildNumber(uint8_t *build)
```

Parameter

| | |
|--------------------|--|
| <code>build</code> | pointer to <code>build</code> variable |
|--------------------|--|

GetReaderSerialDescription**Function description**

Returns reader's descriptive name as a row of 8 chars.

Function declaration (C language)

```
UFR_STATUS GetReaderSerialDescription(uint8_t pSerialDescription[8])
```

Parameter

| | |
|------------------------------------|--|
| <code>pSerialDescription[8]</code> | pointer to <code>pSerialDescription</code> array |
|------------------------------------|--|

ChangeReaderPassword**Function description**

This function is used in Common, Advance and Access Control set of functions.

It defines/changes password which I used for:

- Locking/unlocking keys stored into reader

- Setting date/time of RTC

Function declaration (C language)

```
UFR_STATUS ChangeReaderPassword(uint8_t *old_password,
                                uint8_t *new_password)
```

Parameters

| | |
|---------------------|--|
| old_password | pointer to the 8 bytes array containing current password |
| new_password | pointer to the 8 bytes array containing new password |

ReaderKeyWrite

Function description

Store a new key or change existing key under provided index parameter. The keys are in a special area in EEPROM that can not be read anymore which gains protection.

Function declaration (C language)

```
UFR_STATUS ReaderKeyWrite(const uint8_t *aucKey,
                          uint8_t ucKeyIndex)
```

Parameters

| | |
|-------------------|---|
| aucKey | Pointer to an array of 6 bytes containing the key. Default key values are always "FF FF FF FF FF FF" hex. |
| ucKeyIndex | key Index. Possible values are 0 to 31. |

ReaderKeysLock

Function description

Lock reader's keys to prevent further changing.

Function declaration (C language)

```
UFR_STATUS ReaderKeysLock(const uint8_t *password);
```

Parameter

| | |
|-----------------|---|
| password | pointer to the 8 bytes array containing valid password. |
|-----------------|---|

ReaderKeysUnlock

Function description

Unlock reader's keys if they are locked with previous function.

The factory setting is that reader keys are unlocked.

Function declaration (C language)

```
UFR_STATUS ReaderKeysUnlock(const uint8_t *password);
```

Parameter

| | |
|-----------------|---|
| password | pointer to the 8 bytes array containing valid password. |
|-----------------|---|

ReaderSoftRestart

Function description

This function is used to restart the reader by software. It sets all readers parameters to default values and close RF field which resets all the cards in the field.

Function declaration (C language)

```
UFR_STATUS ReaderSoftRestart(void);
```

No parameters required.

ReadUserData

Function description

Read user data written in device NV memory. User data is 16 byte long.

Function declaration (C language)

```
UFR_STATUS ReadUserData(uint8_t *aucData)
```

Parameter

| | |
|----------------|--|
| aucData | pointer to 16 byte array containing user data. |
|----------------|--|

WriteUserData

Function description

Write user data into device's NV memory. User data is 16 byte long.

Function declaration (C language)

```
UFR_STATUS WriteUserData(uint8_t *aucData)
```

Parameter

| | |
|----------------|--|
| aucData | pointer to 16 byte array containing user data. |
|----------------|--|

UfrEnterSleepMode**Function description**

Turn device into Sleep mode.

Function declaration (C language)

```
UFR_STATUS UfrEnterSleepMode(void)
```

No parameters used.

UfrLeaveSleepMode**Function description**

Wake up device from Sleep mode.

Function declaration (C language)

```
UFR_STATUS UfrLeaveSleepMode(void)
```

No parameters used.

AutoSleepSet**Function description**

Turn device into Sleep mode after certain amount of time.

Function declaration (C language)

```
UFR_STATUS AutoSleepSet(uint8_t seconds_wait)
```

Parameter

| | |
|---------------------|--|
| seconds_wait | variable holding value of seconds to wait before enter into sleep. If parameter is 0x00, AutoSleep feature is turned off (default state). |
|---------------------|--|

AutoSleepGet

Function description

Get status of AutoSleep mode.

Function declaration (C language)

```
UFR_STATUS AutoSleepGet(uint8_t seconds_wait)
```

Parameter

| | |
|---------------------|--|
| seconds_wait | variable holding value of seconds to wait before enter into sleep. If parameter is 0x00, AutoSleep feature is turned off (default state). |
|---------------------|--|

SetSpeedPermanently

Function description

This function is used for setting communication speed between reader and ISO14443-4 cards. For other card types, default speed of 106 kbps is in use.

Function declaration (C language)

```
UFR_STATUS SetSpeedPermanently (uint8_t tx_speed,
                                uint8_t rx_speed)
```

Parameters

| | |
|-----------------|--------------------------------|
| tx_speed | setup value for transmit speed |
| rx_speed | setup value for receive speed |

Valid speed setup values are:

| Const | Configured speed |
|--------------|-------------------------|
| 0 | 106 kbps (default) |
| 1 | 212 kbps |
| 2 | 424 kbps |

On some reader types maximum **rx_speed** is 212 kbps. If you try to set higher speed than possible, reader will automatically set the maximum possible speed.

GetSpeedParameters

Function description

Returns baud rate configured with previous function.

Function declaration (C language)

```
UFR_STATUS GetSpeedParameters(uint8_t *tx_speed,  
                               uint8_t *rx_speed)
```

Parameters

| | |
|-----------------|--|
| tx_speed | pointer to variable, returns configured value for transmit speed |
| rx_speed | pointer to variable, returns configured value for receive speed |

SetAsyncCardIdSendConfig

Function description

This function is used for “Asynchronous UID sending” feature. Returned string contains hexadecimal notation of card ID with one mandatory suffix character and one optional prefix character.

Example:

Card ID is 0xA103C256, prefix is 0x58 ('X'), suffix is 0x59 ('Y')

Returned string is “XA103C256Y”

Function sets configuration parameters for this feature.

Function declaration (C language)

```
UFR_STATUS SetAsyncCardIdSendConfig (uint8_t send_enable,
                                     uint8_t prefix_enable,
                                     uint8_t prefix,
                                     uint8_t suffix,
                                     uint8_t send_removed_enable,
                                     uint32_t async_baud_rate);
```

Parameters

| | |
|----------------------------|---|
| send_enable | turn feature on/off (0/1) |
| prefix_enable | use prefix or not (0/1) |
| prefix | prefix character |
| suffix | suffix character |
| send_removed_enable | Turn feature on/off (0/1). If feature is enabled then Asynchronous UID will also be sent when removing a card from the reader field. |
| async_baud_rate | baud rate value (e.g. 9600) |

GetAsyncCardIdSendConfig**Function description**

Returns info about parameters configured with previous function.

Function declaration (C language)

```
UFR_STATUS GetAsyncCardIdSendConfig (uint8_t *send_enable,
                                     uint8_t *prefix_enable,
                                     uint8_t *prefix,
                                     uint8_t *suffix,
                                     uint8_t *send_removed_enable,
                                     uint32_t *async_baud_rate);
```

Parameters

| | |
|----------------------------|---|
| send_enable | pointer, if feature is on/off (0/1) |
| prefix_enable | pointer, if prefix is used or not (0/1) |
| prefix | pointer to variable holding prefix character |
| suffix | pointer to variable holding suffix character |
| send_removed_enable | Pointer. If value is 0 then feature is off. Otherwise, feature is on. If feature is enabled then Asynchronous UID is sent when the card is removed from the reader field. |
| async_baud_rate | pointer to variable holding configured baud rate |

SetAsyncCardIdSendConfigEx**Function description**

Function sets the parameters of card ID sending.

Function declaration (C language)

```
UFR_STATUS SetAsyncCardIdSendConfigEx(
    uint8_t send_enable,
    uint8_t prefix_enable,
    uint8_t prefix,
    uint8_t suffix,
    uint8_t send_removed_enable,
    uint8_t reverse_byte_order,
    uint8_t decimal_representation,
    uint32_t async_baud_rate);
```

Parameters

| | |
|----------------------|---------------------------|
| send_enable | turn feature on/off (0/1) |
| prefix_enable | use prefix or not (0/1) |
| prefix | prefix character |

| | |
|-------------------------------|--|
| suffix | suffix character |
| send_removed_enable | Turn feature on/off (0/1). If feature is enabled then Asynchronous UID will also be sent when removing a card from the reader field. |
| reverse_byte_order | Turn feature on/off (0/1). If feature is disabled then the order of bytes (UID) will be as on card. If feature is enabled then the order of bytes will be reversed then the card's order of bytes. |
| decimal_representation | Turn feature on/off (0/1). If feature is enabled then the UID will be presented as a decimal number. If feature is disabled then the UID will be presented as a hexadecimal number |
| async_baud_rate | baud rate value (e.g. 9600) |

GetAsyncCardIdSendConfigEx

Function description

Function returns the parameters of card ID sending.

Function declaration (C language)

```

UFR_STATUS
uint8_t
uint8_t
uint8_t
uint8_t
uint8_t
uint8_t
uint8_t
uint32_t *async_baud_rate);

GetAsyncCardIdSendConfigEx(
    *send_enable,
    *prefix_enable,
    *prefix,
    *suffix,
    *send_removed_enable,
    *reverse_byte_order,
    *decimal_representation,

```

Parameters

| | |
|----------------------|-------------------------------------|
| send_enable | pointer to the sending enable flag |
| prefix_enable | pointer to the prefix existing flag |
| prefix | pointer to prefix character |
| suffix | pointer to suffix character |

| | |
|-------------------------------|-------------------------------|
| send_removed_enable | pointer to flag |
| reverse_byte_order | pointer to flag |
| decimal_representation | pointer to flag |
| async_baud_rate | pointer to baud rate variable |

ReaderUISignal

Function description

This function turns sound and light reader signals. Sound signals are performed by reader's buzzer and light signals are performed by reader's LEDs.

There are predefined signal values for sound and light:

| light_signal_mode : | | beep_signal_mode: | |
|------------------------|-------------|-------------------|----------------|
| 0 | None | 0 | None |
| 1 | Long Green | 1 | Short |
| 2 | Long Red | 2 | Long |
| 3 | Alternation | 3 | Double Short |
| 4 | Flash | 4 | Triple Short |
| | | 5 | Triplet Melody |

Function declaration (C language)

```
UFR_STATUS ReaderUISignal(uint8_t light_signal_mode,
                           uint8_t beep_signal_mode)
```

Parameters

| | |
|--------------------------|--------------------------|
| light_signal_mode | value from table (0 - 4) |
| beep_signal_mode | value from table (0 - 5) |

UfrRedLightControl

Function description

This function turns Red LED only.
If "light_status" value is 1, red light will be constantly turned on until receive "light_status" value 0.

Function declaration (C language)

```
UFR_STATUS UfrRedLightControl(uint8_t light_status)
```

Parameter

| | |
|--------------|--------------|
| light_status | value 0 or 1 |
|--------------|--------------|

SetSpeakerFrequency

Function description

This function plays constant sound of "frequency" Hertz.

Function declaration (C language)

```
UFR_STATUS SetSpeakerFrequency(uint16_t frequency)
```

Parameter

| | |
|-----------|-----------------|
| frequency | frequency in Hz |
|-----------|-----------------|

To stop playing sound, send 0 value for "frequency".

SetUartSpeed

From version 5.0.28

Function description

This function sets communication speed (UART baud rate). Allowable values of baud rate are: 9600, 19200, 38400, 57600, 115200, 230400, 460800, 500000, and 1000000 bps. All RS232 devices are supported, and USB devices (Nano FR, Classic) from firmware version 5.0.31.

Function declaration (C language)

```
UFR_STATUS SetUartSpeed(uint32_t baud_rate);
```

Parameter

| | |
|-----------|----------------|
| baud_rate | UART baud rate |
|-----------|----------------|

SetDefaultUartSpeed

From version 5.0.28

Function description

This function returns communication speed (UART baud rate) to default value. For RS23 devices default communication speed is 115200 bps, and for USB devices is 1000000 bps.

For RS232 devices form version 5.0.1 (plus devices), and for USB devices from version 5.0.31.

Function declaration (C language)

```
UFR_STATUS SetDefaultUartSpeed(uint8_t reader_type,
                               uint8_t comm_type,
                               c_string port_name);
```

Parameters

| | |
|--------------------|--|
| reader_type | 1 - USB 2 - RS232 |
| comm_type | 1 - COM port 2 - FTDI |
| port_name | If comm_type is FTDI enter empty string If comm_type is COM port Windows "COMx" Linux "/dev/ttyUSBx" Mac OS "/dev/tty.usbserial-xxxxxxx" |

Handling with multiple readers

If you want to communicate and use multiple readers from an application, you have to follow the initial procedure for enumerating uFR compatible devices and getting their handles. First call ReaderList_UpdateAndGetCount() to prepare internal list of connected devices and then call ReaderList_GetInformation() several times to get information of every reader.

Handle is used to identify certain reader when calling multi-functions (with suffix M).

ReaderList_UpdateAndGetCount

Function description

This is the first function in the order for execution for the multi-reader support.

The function prepare the list of connected uF-readers to the system and returns the number of list items - number of connected uFR devices.

ReaderList_UpdateAndGetCount() scan all communication ports for compatible devices, probes opened readers if still connected, if not close and mark their handles for deletion. If some device is disconnected from system this function should remove its handle.

Function declaration (C language)

```
UFR_STATUS ReaderList_UpdateAndGetCount(int32_t * NumberOfDevices);
```

Parameters

| | |
|------------------------|--|
| NumberOfDevices | how many compatible devices is connected to the system |
|------------------------|--|

Returns: status of execution

ReaderList_GetInformation

Function description

Function for getting all relevant information about connected readers.

You must call the function as many times as there are detected readers. E.g. If you have tree connected readers, detected by ReaderList_UpdateAndGetCount(), you should call this function tree times.

Function declaration (C language)

```

UFR_STATUS ReaderList_GetInformation(
    UFR_HANDLE *DeviceHandle,
    c_string *DeviceSerialNumber,
    int *DeviceType, int *DeviceFWver,
    int *DeviceCommID, int *DeviceCommSpeed,
    c_string *DeviceCommFTDIDSerial,
    c_string *DeviceCommFTDIDescription,
    int *DeviceIsOpened,
    int *DeviceStatus);

```

Parameters

| | |
|----------------------------------|---|
| DeviceHandle | assigned Handle to the uFR reader - pointer for general purpose (void * type in C) |
| DeviceSerialNumber | device serial number, pointer to static reserved information in library (no need to reserve memory space) |
| DeviceType | device identification in Digital Logic AIS database |
| DeviceFWver | version of firmware |
| DeviceCommID | device identification number (master) |
| DeviceCommSpeed | communication speed in bps |
| DeviceCommFTDIDSerial | FTDI COM port identification, pointer to static reserved information in library (no need to reserve memory space) |
| DeviceCommFTDIDescription | FTDI COM port description, pointer to static reserved information in library (no need to reserve memory space) |
| DeviceIsOpened | is Device opened - 0 not opened, other value is opened |
| DeviceStatus | actual device status |

ReaderList_Destroy**Function description**

Force handle deletion when you identify that the reader is no longer connected, and want to

release the handle immediately. If the handle exists in the list of opened devices, function would try to close communication port and destroy the handle.

When uF-reader is disconnected ReaderList_UpdateAndGetCount() will do that (destroy) automatically in next execution.

Function declaration (C language)

```
UFR_STATUS ReaderList_Destroy(UFR_HANDLE DeviceHandle);
```

Parameter

| | |
|---------------------|-----------------------------------|
| DeviceHandle | the handle that will be destroyed |
|---------------------|-----------------------------------|

Example (in C):

```

int main(void)
{
    puts(GetDllVersionStr());

    UFR_STATUS status;
    int32_t NumberOfDevices;

    status = ReaderList_UpdateAndGetCount(&NumberOfDevices);
    if (status)
    {
        // TODO: check error
        printf("ReaderList_UpdateAndGetCount(): error= %s\n",
            UFR_Status2String(status));

        return EXIT_SUCCESS;
    }

    printf("ReaderList_UpdateAndGetCount(): NumberOfDevices= %d\n",
        NumberOfDevices);

    for (int i = 0; i < NumberOfDevices; ++i)
    {
        UFR_HANDLE DeviceHandle;
        c_string DeviceSerialNumber;
        int DeviceType;
        int DeviceFWver;
        int DeviceCommID;
        int DeviceCommSpeed;
        c_string DeviceCommFTDIDSerial;
        c_string DeviceCommFTDIDescription;
        int DeviceIsOpened;
        int DeviceStatus;

        status = ReaderList_GetInformation(&DeviceHandle,
            &DeviceSerialNumber, &DeviceType, &DeviceFWver,
            &DeviceCommID, &DeviceCommSpeed,
            &DeviceCommFTDIDSerial,
            &DeviceCommFTDIDescription,
            &DeviceIsOpened, &DeviceStatus);

        printf("{%d/%d} DeviceHandle= %p, DeviceSerialNumber=
%s, "
            "DeviceType= %X, DeviceFWver= %d, "
            "DeviceCommID= %d, DeviceCommSpeed= %d, "
            "\n\t\t"
            "DeviceCommFTDIDSerial= %s, DeviceCommFTDIDescription=
%s, "
            "\n\t\t"
            "DeviceIsOpened= %d, DeviceStatus= %d\n", i + 1,

```



```
        NumberOfDevices, DeviceHandle, DeviceSerialNumber,  
        DeviceType, DeviceFWver, DeviceCommID,  
        DeviceCommSpeed,  
        DeviceCommFTDISerial, DeviceCommFTDIDescription,  
        DeviceIsOpened, DeviceStatus);  
  
        puts(GetReaderDescriptionM(DeviceHandle));  
    }  
    return EXIT_SUCCESS;  
}
```

Helper library functions

GetDllVersionStr

Function description

This function returns library version as string.

Function declaration (C language)

```
c_string GetDllVersionStr(void)
```

No parameters used.

GetDllVersion

Function description

This function returns library version as number.

Function declaration (C language)

```
uint32_t GetDllVersion(void);
```

Returns compact version number, in little-endian format

Low Byte: Major version number

High Byte: Minor version number

Upper byte: Build number

Master Byte: reserved -

UFR_STATUS2String

Function description

This is helper library function. Returns DL_STATUS result code as readable descriptive data. Return type is string. For DL_STATUS enumeration, please refer to [Appendix: ERROR CODES \(DL_STATUS result\)](#).

Function declaration (C language)

```
c_string UFR_Status2String(const UFR_STATUS status)
```

GetReaderDescription**Function description**

This function returns reader's descriptive name. Return type is string. No parameters required.

Function declaration (C language)

```
c_string GetReaderDescription(void)
```

No parameters used.

Card/tag related commands**General purpose card related commands**

Following functions are applicable to all card types.

| | |
|------------|-------------------|
| UFR_STATUS | GetDlogicCardType |
| UFR_STATUS | GetCardId |
| UFR_STATUS | GetCardIdEx |
| UFR_STATUS | GetLastCardIdEx |

GetDlogicCardType**Function description**

This function returns card type according to DlogicCardType enumeration. For details, please refer to [Appendix: DLogic CardType enumeration](#).

If the card type is not supported, function return the `lpucCardType` value equal to zero :

```
TAG_UNKNOWN = 0x00
```

Function declaration (C language)

```
UFR_STATUS GetDlogicCardType(uint8_t *lpucCardType)
```

Parameter

| | |
|---------------------|---|
| lpucCardType | pointer to <code>lpucCardType</code> variable. Variable <code>lpucCardType</code> holds returned value of actual card type present in RF field. |
|---------------------|---|

GetNfcT2TVersion

Function description

This function returns 8 bytes of the T2T version. All modern T2T chips support this functionality and have in common a total of 8 byte long version response. This function is primarily intended to use with NFC_T2T_GENERIC tags (i.e. tags which return 0x0C in the *lpucCardType parameter of the GetDlogicCardType()).

Function declaration (C language)

```
UFR_STATUS GetNfcT2TVersion(uint8_t lpucVersionResponse[8]);
```

Parameter

| | |
|-------------------------------------|--|
| <code>lpucVersionResponse[8]</code> | array containing 8 bytes which will receive raw T2T version. |
|-------------------------------------|--|

NfcT2TSafeConvertVersion

Function description

This is a helper function for converting raw array of 8 bytes received by calling `GetNfcT2TVersion()`. All modern T2T chips having same or very similar structure of the T2T version data represented in the uFR API by the structure type `t2t_version_t`:

```
typedef struct t2t_version_struct {
    uint8_t header;
    uint8_t vendor_id;
    uint8_t product_type;
    uint8_t product_subtype;
    uint8_t major_product_version;
    uint8_t minor_product_version;
    uint8_t storage_size;
    uint8_t protocol_type;
} t2t_version_t;
```

This function is primarily intended to use with NFC_T2T_GENERIC tags (i.e. tags which return 0x0C in the *lpucCardType parameter of the `GetDlogicCardType()`). Conversion done by this function is "alignment safe".

Function declaration (C language)

```
void NfcT2TSafeConvertVersion(t2t_version_t *version,
                             const uint8_t *version_record);
```

Parameters

| | |
|-----------------------|--|
| version | pointer to the structure of the <code>t2t_version_t</code> type which will receive converted T2T version |
| version_record | pointer to array containing 8 bytes of the raw T2T version acquired using function <code>GetNfcT2TVersion()</code> |

GetCardId

Function description

Returns card UID as a 4-byte array. This function is deprecated and used only for backward compatibility with older firmware versions (before v2.0). We strongly discourage use of this function. This function can't successfully handle 7 byte UIDS.

Function declaration (C language)

```
UFR_STATUS GetCardId(uint8_t *lpucCardType,
                    uint32_t *lpulCardSerial)
```

Parameters

| | |
|-----------------------|--|
| lpucCardType | returns pointer to variable which holds card type according to SAK |
| lpulCardSerial | returns pointer to array of card UID bytes, 4 bytes long ONLY |

GetCardIdEx

Function description

This function returns UID of card actually present in RF field of reader. It can handle all three known types : 4, 7 and 10 byte long UIDs.

This function is recommended for use instead of `GetCardId`.

Function declaration (C language)

```
UFR_STATUS GetCardIdEx(uint8_t *lpucSak,
                      uint8_t *aucUid,
                      uint8_t *lpucUidSize);
```

Parameters

| | |
|--------------------|--|
| lpucSak | returns pointer to variable which holds card type according to SAK |
| aucUid | returns pointer to array of card UID bytes, variable length |
| lpucUidSize | returns pointer to variable holding information about UID length |

| | |
|--|--|
| | |
|--|--|

GetLastCardIdEx

Function description

This function returns UID of last card which was present in RF field of reader. It can handle all three known types : 4, 7 and 10 byte long UIDs. Difference with GetCardIdEx is that card does not be in RF field mandatory, UID value is stored in temporary memory area.

Function declaration (C language)

```
UFR_STATUS GetLastCardIdEx(uint8_t *lpucSak,
                           uint8_t *aucUid,
                           uint8_t *lpucUidSize);
```

Parameters :

| | |
|--------------------|--|
| lpucSak | returns pointer to variable which holds card type according to SAK |
| aucUid | returns pointer to array of card UID bytes, variable length |
| lpucUidSize | returns pointer to variable holding information about UID length |

Mifare Classic specific functions

Functions specific to Mifare Classic ® family of cards (Classic 1K and 4K). All functions are dedicated for use with Mifare Classic ® cards. However, some functions can be used with other card types, mostly in cases of direct addressing scheme and those functions will be highlighted in further text. There are few types of following functions:

- d) Block manipulation functions – direct and indirect addressing
Functions for manipulating data in blocks of 16 byte according to Mifare Classic ® memory structure organization.
- e) Value Block manipulation functions – direct and indirect addressing
Functions for manipulating value blocks byte according to Mifare Classic ® memory structure organization.
- f) Linear data manipulation functions
Functions for manipulating data of Mifare Classic ® memory structure as a Linear data space.

Function's variations

All listed functions have 4 variations according to key mode, as explained earlier in chapter "Mifare Classic authentication modes and usage of keys". Let's take "BlockRead" function as example:

| | |
|----------------|-----------|
| BlockRead | RK mode |
| BlockRead_AKM1 | AKM1 mode |
| BlockRead_AKM2 | AKM2 mode |
| BlockRead_PK | PK mode |

Direct or Indirect addressing

In general, when speaking about direct and indirect addressing functions, both function types does the same thing. Main difference is in a way of block addressing.

Direct addressing functions use absolute value for Block address according to Mifare Classic memory map, where real block address (0-63) corresponds to function parameter value.

Indirect addressing functions use Block-In-Sector approach. Each Sector have 4 blocks (or more, for higher Sectors of the Mifare Classic 4K cards), so function always need two parameters: real Sector address and relative Block address in particular sector.

This approach is very useful for loop usage etc. Generally, it is up to user which one of these two function types will use.

Linear Address Data Space

Writing of consecutive data larger than 1 block (16 bytes) can be pretty tricky because of Mifare Classic memory organization map. Each 4th block is so called "Trailer Block" containing keys and access conditions.

For that purpose, uFR Series API use specific set of functions. User can write data even larger than 1 block without concerning about Trailer Blocks. Reader's firmware will take care of Trailer Blocks and arrange data in consecutive order, automatically jumping over Trailer Blocks. Parameters needed for this purpose are starting address in bytes and data length. Linear Address Data Space always begin at first free byte of specific card. In case of Mifare Classic cards, it is Byte 0 of Block 1 in Sector 0.

These type of functions can be used with other card types and Linear Address Data Space may start at different address. For example in case of Mifare Ultralight, Linear Address Data Space start at byte 0 of Page 4, exactly after OTP bytes page.

Following example shows how Linear Address Data Space looks like in case of Mifare Classic card.

Let's write "Data" of 85 bytes, indexed as 0..84 bytes.

Using LinearWrite function, we will send Data, Starting address 0 and DataLength 85.

Reader's firmware will do the rest in following manner:

| | | | | |
|----------|---------|--------------------|--------------|---|
| Sector 0 | Block 0 | Manufacturer Block | LINEAR SPACE | Linear Space starts here at Byte 0 Jumping over Trailer |
| | Block 1 | Bytes 0 -15 | | |
| | Block 2 | Bytes 16 - 31 | | |
| | Block 3 | Trailer | | |
| Sector 1 | Block 0 | Bytes 32 - 47 | LINEAR SPACE | Jumping over Trailer Rest of Block is not changed (Bytes 5 - 15) |
| | Block 1 | Bytes 48 - 63 | | |
| | Block 2 | Bytes 64 - 79 | | |
| | Block 3 | Trailer | | |
| Sector 2 | Block 0 | Bytes 80- 84 | | |

List of Mifare Classic specific functions

| | | |
|------------|-----------------------------|----|
| UFR_STATUS | BlockRead | *1 |
| UFR_STATUS | BlockWrite | *1 |
| UFR_STATUS | BlockInSectorRead | |
| UFR_STATUS | BlockInSectorWrite | |
| UFR_STATUS | LinearRead | *1 |
| UFR_STATUS | LinearWrite | *1 |
| UFR_STATUS | LinRowRead | *1 |
| UFR_STATUS | LinearFormatCard | |
| UFR_STATUS | SectorTrailerWrite | |
| UFR_STATUS | SectorTrailerWriteUnsafe | |
| UFR_STATUS | ValueBlockRead | |
| UFR_STATUS | ValueBlockWrite | |
| UFR_STATUS | ValueBlockInSectorRead | |
| UFR_STATUS | ValueBlockInSectorWrite | |
| UFR_STATUS | ValueBlockIncrement | |
| UFR_STATUS | ValueBlockDecrement | |
| UFR_STATUS | ValueBlockInSectorIncrement | |
| UFR_STATUS | ValueBlockInSectorDecrement | |

“*1” - function can be used with NFC T2T card types (i.e. all varieties of the Mifare Ultralight, NTAG 203, NTAG 21x, Mikron MIK640D and other NFC_T2T_GENERIC tags).

If you want to use the following functions: ValueBlockRead(), ValueBlockWrite(), ValueBlockInSectorRead(), ValueBlockInSectorWrite(), ValueBlockIncrement(), ValueBlockDecrement(), ValueBlockInSectorIncrement() and ValueBlockInSectorDecrement(), then you need to change access bits for data blocks in chosen sector to one of the “value blocks application” access condition. You can do this using uFR API function SectorTrailerWrite().

BlockRead

Function description

Read particular block using absolute Block address.

Function declaration (C language)

```

UFR_STATUS BlockRead(uint8_t *data,
                     uint8_t block_address,
                     uint8_t auth_mode,
                     uint8_t key_index);

UFR_STATUS BlockRead_AKM1(uint8_t *data,
                          uint8_t block_address,
                          uint8_t auth_mode);

UFR_STATUS BlockRead_AKM2(uint8_t *data,
                          uint8_t block_address,
                          uint8_t auth_mode);

UFR_STATUS BlockRead_PK(uint8_t *data,
                       uint8_t block_address,
                       uint8_t auth_mode,
                       const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS BlockReadSamKey(uint8_t *data,
                          uint8_t block_address,
                          uint8_t auth_mode,
                          uint8_t key_index);

```

Parameters

| | |
|----------------------|--|
| data | Pointer to array of bytes containing data |
| block_address | Absolute block address |
| auth_mode | <p>For Mifare Classic tags defines whether to perform authentication with key A or key B:</p> <p>use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61</p> <p>For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH value 0x61 means “use PWD_AUTH” with BlockRead() or BlockRead_PK() functions. Value 0x60 with BlockRead() or BlockRead_PK() functions means “without PWD_AUTH” and in that case you can send for <i>ucReaderKeyIndex</i> or <i>aucProvidedKey</i> parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only without PWD_AUTH in any case of the valid values (0x60 or 0x61) provided for this parameter.</p> <p>For Mifare Plus tags (PK mode) defines whether to perform authentication with key A or key B:</p> <p>use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81</p> |

| | |
|------------------|--|
| key_index | Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) (fw version to 5.0.28) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15) |
| key | Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode) |

When using this function with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but they must take default values.

BlockWrite

Function description

Write particular block using absolute Block address.

Function declaration (C language)

```
UFR_STATUS BlockWrite(uint8_t *data,
                      uint8_t block_address,
                      uint8_t auth_mode,
                      uint8_t key_index);

UFR_STATUS BlockWrite_AKM1(uint8_t *data,
                           uint8_t block_address,
                           uint8_t auth_mode);

UFR_STATUS BlockWrite_AKM2(uint8_t *data,
                           uint8_t block_address,
                           uint8_t auth_mode);

UFR_STATUS BlockWrite_PK(uint8_t *data,
                         uint8_t block_address,
                         uint8_t auth_mode, const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS BlockWriteSamKey(uint8_t *data,
                            uint8_t block_address,
                            uint8_t auth_mode,
                            uint8_t key_index);
```

Parameters

| | |
|----------------------|---|
| data | Pointer to array of bytes containing data |
| block_address | Absolute block address |
| auth_mode | For Mifare Classic tags defines whether to perform authentication with key A or key B: |

| | |
|------------------|--|
| | use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH value 0x61 means “ use PWD_AUTH ” with BlockWrite() or BlockWrite_PK() functions. Value 0x60 with BlockWrite() or BlockWrite_PK() functions means “ without PWD_AUTH ” and in that case <i>you can send for ucReaderKeyIndex or aucProvidedKey parameters anything you want without influence on the result.</i> <i>For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you</i> <i>can use _AKM1 or _AKM2 function variants only without PWD_AUTH in any</i> <i>case of the valid values (0x60 or 0x61) provided for this parameter.</i> For Mifare Plus tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81 |
| key_index | Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15) |
| key | Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode) |

When using this function with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but they must take default values.

BlockInSectorRead

Function description

Read particular block using relative Block in Sector address.

Function declaration (C language)

```
UFR_STATUS BlockInSectorRead(uint8_t *data, uint8_t sector_address,
                             uint8_t block_in_sector_address,
                             uint8_t auth_mode, uint8_t key_index);
```

```
UFR_STATUS BlockInSectorRead_AKM1(uint8_t *data, uint8_t
sector_address,
                                uint8_t block_in_sector_address,
                                uint8_t auth_mode);
```

```
UFR_STATUS BlockInSectorRead_AKM2(uint8_t *data, uint8_t
sector_address,
                                uint8_t block_in_sector_address,
                                uint8_t auth_mode);
```

```
UFR_STATUS BlockInSectorRead_PK(uint8_t *data, uint8_t sector_address,
                                uint8_t block_in_sector_address,
                                uint8_t auth_mode,
                                const uint8_t *key);
```

*only uFR CS with SAM support

```
UFR_STATUS BlockInSectorReadSamKey(uint8_t *data,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode, uint8_t key_index);
```

Parameters

| | |
|--------------------------------|--|
| data | Pointer to array of bytes containing data |
| sector_address | Absolute Sector address |
| block_in_sector_address | Block address in Sector |
| auth_mode | <p>For Mifare Classic tags defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61</p> <p>For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH value 0x61 means “use PWD_AUTH” with BlockInSectorRead() or BlockInSectorRead_PK() functions. Value 0x60 with BlockInSectorRead() or BlockInSectorRead_PK() functions means “without PWD_AUTH” and in that case you can send for ucReaderKeyIndex or aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only without PWD_AUTH in any case of the valid values (0x60 or 0x61) provided for this parameter.</p> <p>For Mifare Plus tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81</p> |
| key_index | Index of reader key to be used (RK mode) |

| | |
|------------|--|
| | For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For keys into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15) |
| key | Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode) |

BlockInSectorWrite

Function description

Write particular block using relative Block in Sector address.

Function declaration (C language)

```
UFR_STATUS BlockInSectorWrite(uint8_t *data, uint8_t sector_address,
                              uint8_t block_in_sector_address,
                              uint8_t auth_mode, uint8_t key_index);
```

```
UFR_STATUS BlockInSectorWrite_AKM1(uint8_t *data,
                                     uint8_t sector_address,
                                     uint8_t block_in_sector_address,
                                     uint8_t auth_mode);
```

```
UFR_STATUS BlockInSectorWrite_AKM2(uint8_t *data,
                                     uint8_t sector_address,
                                     uint8_t block_in_sector_address,
                                     uint8_t auth_mode);
```

```
UFR_STATUS BlockInSectorWrite_PK(uint8_t *data, uint8_t sector_address,
                                  uint8_t block_in_sector_address,
                                  uint8_t auth_mode, const uint8_t *key);
```

*only uFR CS with SAM support

```
UFR_STATUS BlockInSectorWriteSamKey(uint8_t *data,
                                     uint8_t sector_address,
                                     uint8_t block_in_sector_address,
                                     uint8_t auth_mode, uint8_t key_index);
```

Parameters

| | |
|--------------------------------|---|
| data | Pointer to array of bytes containing data |
| sector_address | Absolute Sector address |
| block_in_sector_address | Block address in Sector |
| auth_mode | For Mifare Classic tags defines whether to perform |

| | |
|------------------|--|
| | <p>authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH value 0x61 means “use PWD_AUTH” with BlockInSectorWrite() or BlockInSectorWrite_PK() functions. Value 0x60 with BlockInSectorWrite() or BlockInSectorWrite_PK() functions means “without PWD_AUTH” and in that case you can send for ucReaderKeyIndex or aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only without PWD_AUTH in any case of the valid values (0x60 or 0x61) provided for this parameter. For Mifare Plus tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81</p> |
| key_index | <p>Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For keys into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)</p> |
| key | <p>Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)</p> |

LinearRead

Function description

Group of functions for linear reading in uFR firmware utilise FAST_READ ISO 14443-3 command with NTAG21x and Mifare Ultralight EV1 tags.

Function declaration (C language)

```
UFR_STATUS LinearRead(uint8_t *Data, uint16_t linear_address,
                      uint16_t length, uint16_t *bytes_returned,
                      uint8_t auth_mode, uint8_t key_index);
```

```
UFR_STATUS LinearRead_AKM1(uint8_t *Data, uint16_t linear_address,
                           uint16_t length, uint16_t *bytes_returned, uint8_t
                           auth_mode);
```

```
UFR_STATUS LinearRead_AKM2(uint8_t *Data, uint16_t linear_address,
                           uint16_t length, uint16_t *bytes_returned, uint8_t
                           auth_mode);
```

```
UFR_STATUS LinearRead_PK(uint8_t *Data, uint16_t linear_address,
                         uint16_t length, uint16_t *bytes_returned,
                         uint8_t auth_mode, const uint8_t *key);
```

**only uFR CS with SAM support*

```
UFR_STATUS LinearReadSamKey(uint8_t *Data, uint16_t linear_address,
                            uint16_t length, uint16_t *bytes_returned,
                            uint8_t auth_mode, uint8_t key_index);
```

Parameters

| | |
|-----------------------|--|
| data | Pointer to array of bytes containing data |
| linear_address | Address of byte – where to start reading |
| length | Length of data – how many bytes to read |
| bytes_returned | Pointer to variable holding how many bytes are returned |
| auth_mode | <p>For Mifare Classic tags defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61</p> <p>For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH value 0x61 means “use PWD_AUTH” with LinearRead() or LinearRead_PK() functions. Value 0x60 with LinearRead() or LinearRead_PK() functions means “without PWD_AUTH” and in that case you can send for ucReaderKeyIndex or aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only without PWD_AUTH in any case of the valid values (0x60 or 0x61) provided for this parameter.</p> <p>For Mifare Plus tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81</p> |
| key_index | Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For keys into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from |

| | |
|------------|--|
| | 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15) |
| key | Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode) |

When using this functions with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but must take default values.

LinearWrite

Function description

These functions are used for writing data to the card using emulation of the linear address space. The method for proving authenticity is determined by the suffix in the functions names.

Function declaration (C language)


```

UFR_STATUS LinearWrite(uint8_t *Data,
                      uint16_t linear_address,
                      uint16_t length,
                      uint16_t *bytes_returned,
                      uint8_t auth_mode,
                      uint8_t key_index);

UFR_STATUS LinearWrite_AKM1(uint8_t *Data,
                           uint16_t linear_address,
                           uint16_t length,
                           uint16_t *bytes_returned,
                           uint8_t auth_mode);

UFR_STATUS LinearWrite_AKM2(uint8_t *Data,
                           uint16_t linear_address,
                           uint16_t length,
                           uint16_t *bytes_returned,
                           uint8_t auth_mode);

UFR_STATUS LinearWrite_PK(uint8_t *Data,
                          uint16_t linear_address,
                          uint16_t length,
                          uint16_t *bytes_returned,
                          uint8_t auth_mode,
                          const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS LinearWriteSamKey(uint8_t *Data,
                             uint16_t linear_address,
                             uint16_t length,
                             uint16_t *bytes_returned,
                             uint8_t auth_mode,
                             uint8_t key_index);

```

Parameters

| | |
|-----------------------|---|
| data | Pointer to array of bytes containing data |
| linear_address | Address of byte – where to start writing |
| length | Length of data – how many bytes to write |
| bytes_returned | Pointer to variable holding how many bytes are returned |
| auth_mode | <p>For Mifare Classic tags defines whether to perform authentication with key A or key B:</p> <p>use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61</p> <p>For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH value 0x61 means “use PWD_AUTH” with LinearWrite() or LinearWrite_PK() functions. Value 0x60 with LinearWrite() or LinearWrite_PK() functions means “without PWD_AUTH” and in that case you can send for ucReaderKeyIndex or aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only without PWD_AUTH in any case of the valid values (0x60 or 0x61) provided for this parameter.</p> |

| | |
|------------------|--|
| | For Mifare Plus tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81 |
| key_index | Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For keys into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15) |
| key | Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode) |

When using this function with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but must take default values.

LinRowRead

Function description

Read Linear data Address Space. On the contrary of LinearRead functions, this functions read whole card including trailer blocks and manufacturer block.

This function is useful when making “dump” of the whole card.

Group of functions for linear reading in uFR firmware utilise FAST_READ ISO 14443-3 command with NTAG21x and Mifare Ultralight EV1 tags.

Function declaration (C language)

```
UFR_STATUS LinRowRead(uint8_t *Data,  
                      uint16_t linRow_address,  
                      uint16_t length,  
                      uint16_t *bytes_returned,  
                      uint8_t auth_mode,  
                      uint8_t key_index);  
  
UFR_STATUS LinRowRead_AKM1(uint8_t *Data,  
                           uint16_t linRow_address,  
                           uint16_t length,  
                           uint16_t *bytes_returned,  
                           uint8_t auth_mode);  
  
UFR_STATUS LinRowRead_AKM2(uint8_t *Data,  
                           uint16_t linRow_address,  
                           uint16_t length,  
                           uint16_t *bytes_returned,  
                           uint8_t auth_mode);  
  
UFR_STATUS LinRowRead_PK(uint8_t *Data,  
                         uint16_t linRow_address,  
                         uint16_t length,
```

```
uint16_t *bytes_returned,
uint8_t auth_mode,
const uint8_t *key);
```

Parameters

| | |
|-----------------------|--|
| data | Pointer to array of bytes containing data |
| linear_address | Address of byte – where to start reading |
| length | Length of data – how many bytes to read |
| bytes_returned | Pointer to variable holding how many bytes are returned |
| auth_mode | <p>For Mifare Classic tags defines whether to perform authentication with key A or key B:</p> <p>use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61</p> <p>For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH value 0x61 means “use PWD_AUTH” with LinRowRead() or LinRowRead_PK() functions. Value 0x60 with LinRowRead() or LinRowRead_PK() functions means “without PWD_AUTH” and in that case you can send for ucReaderKeyIndex or aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only without PWD_AUTH in any case of the valid values (0x60 or 0x61) provided for this parameter.</p> |
| key_index | Index of reader’s key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

When using this function with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but they must take default values.

LinearFormatCard

Function description

This function is specific to Mifare Classic cards only. It performs “Format card” operation - write new Sector Trailer values on whole card at once. It writes following data:

KeyA, Block Access Bits, Trailer Access Bits, GeneralPurposeByte(GPB), KeyB, same as construction of Sector Trailer.

| | | | |
|-------------|---------------------------------------|--------|---------------|
| Bytes 0 - 5 | Bytes 6 - 8 | Byte 9 | Bytes 10 - 15 |
| KeyA | Block Access & Trailer Access Bits | GPB | KeyB |

For more information, please refer to Mifare Classic Keys and Access Conditions in this document.

Mifare Plus using.

For firmware versions from 5.0.29 and library versions from 5.0.19, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1

keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provide to reader.

Function declaration (C language)

```
UFR_STATUS LinearFormatCard(const uint8_t *new_key_A,
                           uint8_t blocks_access_bits,
                           uint8_t sector_trailers_access_bits,
                           uint8_t sector_trailers_byte9,
                           const uint8_t *new_key_B,
                           uint8_t *lpucSectorsFormatted,
                           uint8_t auth_mode,
                           uint8_t key_index);
```

```
UFR_STATUS LinearFormatCard_AKM1(const uint8_t *new_key_A,
                                uint8_t blocks_access_bits,
                                uint8_t sector_trailers_access_bits,
                                uint8_t sector_trailers_byte9,
                                const uint8_t *new_key_B,
                                uint8_t *lpucSectorsFormatted,
                                uint8_t auth_mode);
```

```
UFR_STATUS LinearFormatCard_AKM2(const uint8_t *new_key_A,
                                uint8_t blocks_access_bits,
                                uint8_t sector_trailers_access_bits,
                                uint8_t sector_trailers_byte9,
                                const uint8_t *new_key_B,
                                uint8_t *lpucSectorsFormatted,
                                uint8_t auth_mode);
```

```
UFR_STATUS LinearFormatCard_PK(const uint8_t *new_key_A,
                              uint8_t blocks_access_bits,
                              uint8_t sector_trailers_access_bits,
                              uint8_t sector_trailers_byte9,
                              const uint8_t *new_key_B,
                              uint8_t *lpucSectorsFormatted,
                              uint8_t auth_mode,
                              const uint8_t *key);
```

These functions are used for new keys A and B writing as well as access bits in the trailers of all card sectors. Ninth bit setting is enabled. The same value is set for the entire card. If you need to prove authenticity on the base of previous keys, these functions are suitable to initialize the new card or re-initialize the card with the same keys and access rights for all sectors.

Parameters

| | |
|------------------------------------|---|
| new_key_A | Pointer on 6 bytes array containing a new KeyA |
| blocks_access_bits | Block Access permissions bits. Values 0 to 7 |
| sector_trailers_access_bits | Sector Trailer Access permissions bits. Values 0 to 7 |
| sector_trailers_byte9 | GPB value |
| new_key_B | Pointer on 6 bytes array containing a new KeyA |

| | |
|-----------------------------|---|
| lpucSectorsFormatted | Pointer to variable holding return value how many sectors are successfully formatted |
| auth_mode | Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

This function can't be used with other card types except Mifare Classic.

GetCardSize

Function description

Function returns size of user data space on the card (LinearSize), and size of total data space on the card (RawSize). The user data space is accessed via functions LinearWrite and LinearRead. Total data space is accessed via functions LinRowWrite and LinRowRead. For example Mifare Classic 1K card have 752 bytes of user data space (sector trailers and block 0 are not included), and 1024 bytes of total data space.

Function declaration (C language)

```
UFR_STATUS GetCardSize(uint32_t *lpulLinearSize,
                        uint32_t *lpulRawSize);
```

Parameters

| | |
|-----------------------|--|
| lpulLinearSize | pointer to variable which contain size of user data space |
| lpulRawSize | pointer to variable which contain size of total data space |

SectorTrailerWrite

Function description

This function is specific to Mifare Classic cards only. It writes new Sector Trailer value at one Sector Trailer. It writes following data:

KeyA, Block Access Bits, Trailer Access Bits, GeneralPurposeByte(GPB), KeyB, same as construction of Sector Trailer.

Mifare Plus using.

For firmware versions from 5.0.29 and library versions from 5.0.19, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provide to reader.

Function declaration (C language)

```

UFR_STATUS SectorTrailerWrite(uint8_t addressing_mode,
                               uint8_t address,
                               const uint8_t *new_key_A,
                               uint8_t block0_access_bits,
                               uint8_t block1_access_bits,
                               uint8_t block2_access_bits,
                               uint8_t sector_trailers_access_bits,
                               uint8_t sector_trailers_byte9,
                               const uint8_t *new_key_B,
                               uint8_t auth_mode,
                               uint8_t key_index);

UFR_STATUS SectorTrailerWrite_AKM1(uint8_t addressing_mode,
                                     uint8_t address,
                                     const uint8_t *new_key_A,
                                     uint8_t block0_access_bits,
                                     uint8_t block1_access_bits,
                                     uint8_t block2_access_bits,
                                     uint8_t sector_trailers_access_bits,
                                     uint8_t sector_trailers_byte9,
                                     const uint8_t *new_key_B,
                                     uint8_t auth_mode);

UFR_STATUS SectorTrailerWrite_AKM2(uint8_t addressing_mode,
                                     uint8_t address,
                                     const uint8_t *new_key_A,
                                     uint8_t block0_access_bits,
                                     uint8_t block1_access_bits,
                                     uint8_t block2_access_bits,
                                     uint8_t sector_trailers_access_bits,
                                     uint8_t sector_trailers_byte9,
                                     const uint8_t *new_key_B,
                                     uint8_t auth_mode);

UFR_STATUS SectorTrailerWrite_PK(uint8_t addressing_mode,
                                  uint8_t address,
                                  const uint8_t *new_key_A,
                                  uint8_t block0_access_bits,
                                  uint8_t block1_access_bits,
                                  uint8_t block2_access_bits,
                                  uint8_t sector_trailers_access_bits,
                                  uint8_t sector_trailers_byte9,
                                  const uint8_t *new_key_B,
                                  uint8_t auth_mode,
                                  const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS SectorTrailerWriteSamKey(uint8_t addressing_mode,
                                     uint8_t address,

```

```

const uint8_t *new_key_A,
uint8_t block0_access_bits,
uint8_t block1_access_bits,
uint8_t block2_access_bits,
uint8_t sector_trailers_access_bits,
uint8_t sector_trailers_byte9,
const uint8_t *new_key_B,
uint8_t auth_mode,
uint8_t key_index);

```

Parameters

| | |
|------------------------------------|---|
| addressing_mode | Defines if Absolute (0) or Relative (1) Block Addressing mode is used |
| address | Address of Trailer according to addressing_mode |
| new_key_A | Pointer on 6 bytes array containing a new KeyA |
| block0_access_bits | Access Permissions Bits for Block 0. Values 0 to 7 |
| block1_access_bits | Access Permissions Bits for Block 1. Values 0 to 7 |
| block2_access_bits | Access Permissions Bits for Block 2. Values 0 to 7 |
| sector_trailers_access_bits | Sector Trailer Access permissions bits. Values 0 to 7 |
| sector_trailers_byte9 | GPB value |
| new_key_B | Pointer on 6 bytes array containing a new KeyB |
| auth_mode | Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

This function can't be used with other card types except Mifare Classic.

For "Block Access Bits" please refer to Mifare Classic Keys and Access Conditions in this document.

For Mifare Classic 4K (MF1S70), in higher addresses range (Sectors 31 - 39), where one sector has 16 blocks, `block0_access_bits` corresponds to blocks 0-4, `block1_access_bits` corresponds to blocks 5-9 and `block2_access_bits` corresponds to blocks 10-15.

SectorTrailerWriteUnsafe

Function description

This function is specific to Mifare Classic cards only. It writes new Sector Trailer value at one Sector Trailer. It writes following data:

KeyA, Block Access Bits, Trailer Access Bits, GeneralPurposeByte(GPB), KeyB, same as construction of Sector Trailer.

Difference between this function and SectorTrailerWrite is :

- `SectorTrailerWrite` will check parameters and “safely” write them into trailer, non valid values will not be written
- `SectorTrailerWriteUnsafe` writes array of 16 bytes as raw binary trailer representation, any value can be written.

USE THIS FUNCTION WITH CAUTION, WRONG VALUES CAN DESTROY CARD!

Function declaration (C language)

```
UFR_STATUS SectorTrailerWriteUnsafe(uint8_t addressing_mode,
                                     uint8_t address,
                                     uint8_t *sector_trailer,
                                     uint8_t auth_mode,
                                     uint8_t key_index);

UFR_STATUS SectorTrailerWriteUnsafe_AKM1(uint8_t addressing_mode,
                                           uint8_t address,
                                           uint8_t *sector_trailer,
                                           uint8_t auth_mode);

UFR_STATUS SectorTrailerWriteUnsafe_AKM2(uint8_t addressing_mode,
                                           uint8_t address,
                                           uint8_t *sector_trailer,
                                           uint8_t auth_mode);

UFR_STATUS SectorTrailerWriteUnsafe_PK(uint8_t addressing_mode,
                                       uint8_t address,
                                       uint8_t *sector_trailer,
                                       uint8_t auth_mode,
                                       const uint8_t *key);
```

Parameters

| | |
|------------------------|---|
| addressing_mode | Defines if Absolute (0) or Relative (1) Block Addressing mode is used |
| address | Address of Trailer according to <code>addressing_mode</code> |
| sector_trailers | Pointer to 16 byte array as binary representation of Sector Trailer |
| auth_mode | Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

This function can't be used with other card types except Mifare Classic.

ValueBlockRead

Function description

Read particular Value block using absolute Block address. This function uses Mifare Classic specific mechanism of reading value which is stored into whole block. Value blocks have a fixed data format which permits error detection and correction and a backup management. Value is a signed 4-byte value and it is stored three times, twice non-inverted and once inverted. Negative

numbers are stored in standard 2's complement format. For more info, please refer to Mifare Classic documentation.

Function declaration (C language)

```
UFR_STATUS ValueBlockRead(int32_t *value,
                          uint8_t *value_addr,
                          uint8_t block_address,
                          uint8_t auth_mode,
                          uint8_t key_index);

UFR_STATUS ValueBlockRead_AKM1(int32_t *value,
                               uint8_t *value_addr,
                               uint8_t block_address,
                               uint8_t auth_mode);

UFR_STATUS ValueBlockRead_AKM2(int32_t *value,
                               uint8_t *value_addr,
                               uint8_t block_address,
                               uint8_t auth_mode);

UFR_STATUS ValueBlockRead_PK(int32_t *value,
                             uint8_t *value_addr,
                             uint8_t block_address,
                             uint8_t auth_mode,
                             const uint8_t *key);
```

*only uFR CS with SAM support

```
UFR_STATUS ValueBlockReadSamKey(int32_t *value,
                                uint8_t *value_addr,
                                uint8_t block_address,
                                uint8_t auth_mode,
                                uint8_t key_index);
```

Parameters

| | |
|----------------------|--|
| value | Pointer to variable where retrieved value will be stored |
| Value_addr | Signifies a 1-byte address, which can be used to save the storage address of a block, when implementing a powerful backup management. For more info, please refer to Mifare Classic documentation. |
| block_address | Absolute block address |
| auth_mode | Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

This functions can't be used with other card types except Mifare Classic.

ValueBlockWrite

Function description

Write particular Value block using absolute Block address. This function uses Mifare Classic specific mechanism of writing value which is stored into whole block. Value blocks have a fixed data format which permits error detection and correction and a backup management. Value is a signed 4-byte value and it is stored three times, twice non-inverted and once inverted. Negative numbers are stored in standard 2's complement format. For more info, please refer to Mifare Classic documentation.

Function declaration (C language)

```
UFR_STATUS ValueBlockWrite(int32_t *value,
                           uint8_t *value_addr,
                           uint8_t block_address,
                           uint8_t auth_mode,
                           uint8_t key_index);

UFR_STATUS ValueBlockWrite_AKM1(int32_t *value,
                                uint8_t *value_addr,
                                uint8_t block_address,
                                uint8_t auth_mode);

UFR_STATUS ValueBlockWrite_AKM2(int32_t *value,
                                uint8_t *value_addr,
                                uint8_t block_address,
                                uint8_t auth_mode);

UFR_STATUS ValueBlockWrite_PK(int32_t *value,
                              uint8_t *value_addr,
                              uint8_t block_address,
                              uint8_t auth_mode,
                              const uint8_t *key);

*only uFR CS with SAM support

UFR_STATUS ValueBlockWriteSamKey(int32_t *value,
                                 uint8_t *value_addr,
                                 uint8_t block_address,
                                 uint8_t auth_mode,
                                 uint8_t key_index);
```

Parameters

| | |
|----------------------|--|
| value | Pointer to value to be stored |
| Value_addr | Signifies a 1-byte address, which can be used to save the storage address of a block, when implementing a powerful backup management. For more info, please refer to Mifare Classic documentation. |
| block_address | Absolute block address |
| auth_mode | Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

This function can't be used with other card types except Mifare Classic.

ValueBlockInSectorRead

Function description

Read particular Value block using absolute Block address. This function uses Mifare Classic specific mechanism of reading value which is stored into whole block. Value blocks have a fixed data format which permits error detection and correction and a backup management. Value is a signed 4-byte value and it is stored three times, twice non-inverted and once inverted. Negative numbers are stored in standard 2's complement format. For more info, please refer to Mifare Classic documentation.

Function declaration (C language)

```
UFR_STATUS ValueBlockInSectorRead(int32_t *value,
                                   uint8_t *value_addr,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode,
                                   uint8_t key_index);
```

```
UFR_STATUS ValueBlockInSectorRead_AKM1(int32_t *value,
                                         uint8_t *value_addr,
                                         uint8_t sector_address,
                                         uint8_t block_in_sector_address,
                                         uint8_t auth_mode);
```

```
UFR_STATUS ValueBlockInSectorRead_AKM2(int32_t *value,
                                         uint8_t *value_addr,
                                         uint8_t sector_address,
                                         uint8_t block_in_sector_address,
                                         uint8_t auth_mode);
```

```
UFR_STATUS ValueBlockInSectorRead_PK(int32_t *value,
                                       uint8_t *value_addr,
                                       uint8_t sector_address,
                                       uint8_t block_in_sector_address,
                                       uint8_t auth_mode,
                                       const uint8_t *key);
```

*only uFR CS with SAM support

```
UFR_STATUS ValueBlockInSectorReadSamKey(int32_t *value,
                                         uint8_t *value_addr,
                                         uint8_t sector_address,
                                         uint8_t block_in_sector_address,
                                         uint8_t auth_mode,
                                         uint8_t key_index);
```

Parameters

| | |
|--------------------------------|--|
| value | Pointer to variable where retrieved value will be stored |
| Value_addr | Signifies a 1-byte address, which can be used to save the storage address of a block, when implementing a powerful backup management. For more info, please refer to Mifare Classic documentation. |
| sector_address | Absolute Sector address |
| block_in_sector_address | Block address in Sector |
| auth_mode | Authentication mode : use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes |

| | |
|--|-----------|
| | (PK mode) |
|--|-----------|

This function can't be used with other card types except Mifare Classic.

ValueBlockInSectorWrite

Function description

Write particular Value block using absolute Block address. This function uses Mifare Classic specific mechanism of writing value which is stored into whole block. Value blocks have a fixed data format which permits error detection and correction and a backup management. Value is a signed 4-byte value and it is stored three times, twice non-inverted and once inverted. Negative numbers are stored in standard 2's complement format. For more info, please refer to Mifare Classic documentation.

Function declaration (C language)

```
UFR_STATUS ValueBlockInSectorWrite(int32_t value,
                                   uint8_t value_addr,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode,
                                   uint8_t key_index);
```

```
UFR_STATUS ValueBlockInSectorWrite_AKM1(int32_t value,
                                         uint8_t value_addr,
                                         uint8_t sector_address,
                                         uint8_t block_in_sector_address,
                                         uint8_t auth_mode);
```

```
UFR_STATUS ValueBlockInSectorWrite_AKM2(int32_t value,
                                         uint8_t value_addr,
                                         uint8_t sector_address,
                                         uint8_t block_in_sector_address,
                                         uint8_t auth_mode);
```

```
UFR_STATUS ValueBlockInSectorWrite_PK(int32_t value,
                                       uint8_t value_addr,
                                       uint8_t sector_address,
                                       uint8_t block_in_sector_address,
                                       uint8_t auth_mode,
                                       const uint8_t *key);
```

*only uFR CS with SAM support

```
UFR_STATUS ValueBlockInSectorWriteSamKey(int32_t value,
                                          uint8_t value_addr,
                                          uint8_t sector_address,
                                          uint8_t block_in_sector_address,
                                          uint8_t auth_mode,
                                          uint8_t key_index);
```

Parameters

| | |
|--------------------------------|--|
| value | Pointer to value to be stored |
| Value_addr | Signifies a 1-byte address, which can be used to save the storage address of a block, when implementing a powerful backup management. For more info, please refer to Mifare Classic documentation. |
| sector_address | Absolute Sector address |
| block_in_sector_address | Block address in Sector |
| auth_mode | Authentication mode : use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

This function can't be used with other card types except Mifare Classic.

ValueBlockIncrement

Function description

Increments particular Value block with specified value using absolute Block address.

Function declaration (C language)

```
UFR_STATUS ValueBlockIncrement(int32_t increment_value,
                               uint8_t block_address,
                               uint8_t auth_mode,
                               uint8_t key_index);

UFR_STATUS ValueBlockIncrement_AKM1(int32_t increment_value,
                                     uint8_t block_address,
                                     uint8_t auth_mode);

UFR_STATUS ValueBlockIncrement_AKM2(int32_t increment_value,
                                     uint8_t block_address,
                                     uint8_t auth_mode);

UFR_STATUS ValueBlockIncrement_PK(int32_t increment_value,
                                  uint8_t block_address,
                                  uint8_t auth_mode,
                                  const uint8_t *key);

*only uFR CS with SAM support

UFR_STATUS ValueBlockIncrementSamKey(int32_t increment_value,
                                     uint8_t block_address,
                                     uint8_t auth_mode,
                                     uint8_t key_index);
```

Parameters

| | |
|------------------------|--|
| increment_value | value showing how much initial block value will be incremented |
| block_address | Absolute block address |
| auth_mode | Authentication mode : use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

This function can't be used with other card types except Mifare Classic.

ValueBlockDecrement

Function description

Decrements particular Value block with specified value using absolute Block address.

Function declaration (C language)

```
UFR_STATUS ValueBlockDecrement(int32_t decrement_value,
                                uint8_t block_address,
                                uint8_t auth_mode,
                                uint8_t key_index);

UFR_STATUS ValueBlockDecrement_AKM1(int32_t decrement_value,
                                      uint8_t block_address,
                                      uint8_t auth_mode);

UFR_STATUS ValueBlockDecrement_AKM2(int32_t decrement_value,
                                      uint8_t block_address,
                                      uint8_t auth_mode);

UFR_STATUS ValueBlockDecrement_PK(int32_t decrement_value,
                                   uint8_t block_address,
                                   uint8_t auth_mode,
                                   const uint8_t *key);

*only uFR CS with SAM support

UFR_STATUS ValueBlockDecrementSamKey(int32_t decrement_value,
                                      uint8_t block_address,
                                      uint8_t auth_mode,
                                      uint8_t key_index);
```

Parameters

| | |
|------------------------|--|
| increment_value | value showing how much initial block value will be decremented |
| block_address | Absolute block address |
| auth_mode | Authentication mode : use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

This function can't be used with other card types except Mifare Classic.

ValueBlockInSectorIncrement

Function description

Increments particular Value block with specified value using Block in Sector address.

Function declaration (C language)

UFR_STATUS

```
ValueBlockInSectorIncrement(int32_t increment_value,
                           uint8_t sector_address,
                           uint8_t block_in_sector_address,
                           uint8_t auth_mode,
                           uint8_t key_index);
```

UFR_STATUS

```
ValueBlockInSectorIncrement_AKM1(int32_t increment_value,
                                  uint8_t sector_address,
                                  uint8_t block_in_sector_address,
                                  uint8_t auth_mode);
```

UFR_STATUS

```
ValueBlockInSectorIncrement_AKM2(int32_t increment_value,
                                  uint8_t sector_address,
                                  uint8_t block_in_sector_address,
                                  uint8_t auth_mode);
```

UFR_STATUS

```
ValueBlockInSectorIncrement_PK(int32_t increment_value,
                               uint8_t sector_address,
                               uint8_t block_in_sector_address,
                               uint8_t auth_mode,
                               const uint8_t *key);
```

*only uFR CS with SAM support

UFR_STATUS

```
ValueBlockInSectorIncrementSamKey(int32_t increment_value,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode,
                                   uint8_t key_index);
```

Parameters

| | |
|--------------------------------|--|
| increment_value | value showing how much initial block value will be incremented |
| sector_address | Absolute Sector address |
| block_in_sector_address | Block address in Sector |
| auth_mode | Authentication mode : use KeyA - MIFARE_AUTHENT1A = 0x60 Or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK mode) |

This function can't be used with other card types except Mifare Classic.

ValueBlockInSectorDecrement

Function description

Decrements particular Value block with specified value using Block in Sector address.

Function declaration (C language)

UFR_STATUS

```
ValueBlockInSectorDecrement(int32_t decrement_value,
                             uint8_t sector_address,
                             uint8_t block_in_sector_address,
                             uint8_t auth_mode,
                             uint8_t key_index);
```

UFR_STATUS

```
ValueBlockInSectorDecrement_AKM1(int32_t decrement_value,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode);
```

UFR_STATUS

```
ValueBlockInSectorDecrement_AKM2(int32_t decrement_value,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode);
```

UFR_STATUS

```
ValueBlockInSectorDecrement_PK(int32_t decrement_value,
                                uint8_t sector_address,
                                uint8_t block_in_sector_address,
                                uint8_t auth_mode,
                                const uint8_t *key);
```

*only uFR CS with SAM support

UFR_STATUS

```
ValueBlockInSectorDecrementSamKey(int32_t decrement_value,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode,
                                   uint8_t key_index);
```

Parameters

| | |
|--------------------------------|--|
| decrement_value | value showing how much initial block value will be decremented |
| sector_address | Absolute Sector address |
| block_in_sector_address | Block address in Sector |
| auth_mode | Authentication mode : use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 |
| key_index | Index of reader's key to be used (RK mode) |
| key | Pointer to 6 byte array containing key bytes (PK) |

| | |
|--|-------|
| | mode) |
|--|-------|

This function can't be used with other card types except Mifare Classic.

Additional general functions for working with the cards

Functions that support NDEF records

get_ndef_record_count

Function description

Function returns the number of NDEF messages that have been read from the card, and number of NDEF records, number of NDEF empty messages. Also, function returns array of bytes containing number of messages pairs. First byte of pair is message ordinal, and second byte is number of NDEF records in that message. Message ordinal starts from 1.

Function declaration (C language)

```
UFR_STATUS get_ndef_record_count(
    uint8_t *ndef_message_cnt,
    uint8_t *ndef_record_cnt,
    uint8_t *ndef_record_array,
    uint8_t *empty_ndef_message_cnt);
```

Parameters

| | |
|-------------------------------------|--|
| <code>ndef_message_cnt</code> | pointer to the variable containing number of NDEF messages |
| <code>ndef_record_cnt</code> | pointer to the variable containing number of NDEF record |
| <code>ndef_record_array</code> | pointer to the array of bytes containing pairs (message ordinal – number of records) |
| <code>empty_ndef_message_cnt</code> | pointer to the variable containing number of empty messages |

read_ndef_record

Function description

Function returns TNF, type of record, ID and payload from the NDEF record. NDEF record shall be elected by the message ordinal and record ordinal in this message.

Function declaration (C language)

```

UFR_STATUS read_ndef_record(uint8_t message_nr,
                             uint8_t record_nr,
                             uint8_t *tnf,
                             uint8_t *type_record,
                             uint8_t *type_length,
                             uint8_t *id,
                             uint8_t *id_length,
                             uint8_t *payload,
                             uint32_t *payload_length);

```

Parameters

| | |
|-----------------------|--|
| message_nr | NDEF message ordinal (starts from 1) |
| record_nr | NDEF record ordinal (in message) |
| tnf | pointer to the variable containing TNF of record |
| type_record | pointer to array containing type of record |
| type_length | pointer to the variable containing length of type of record string |
| id | pointer to array containing ID of record |
| id_length | pointer to the variable containing length of ID of record string |
| payload | pointer to array containing payload of record |
| payload_length | pointer to the variable containing length of payload |

write_ndef_record**Function description**

Function adds a record to the end of message, if one or more records already exist in this message. If current message is empty, then this empty record will be replaced with the record. Parameters of function are: ordinal of message, TNF, type of record, ID, payload. Function also returns pointer to the variable which reported that the card formatted for NDEF using (card does not have a capability container, for example new Mifare Ultralight, or Mifare Classic card).

Function declaration (C language)

```

UFR_STATUS write_ndef_record(uint8_t message_nr,
                              uint8_t *tnf,
                              uint8_t *type_record,
                              uint8_t *type_length,
                              uint8_t *id,
                              uint8_t *id_length,
                              uint8_t *payload,
                              uint32_t *payload_length,
                              uint8_t *card_formatted);

```

Parameters

| | |
|-----------------------|---|
| message_nr | NDEF message ordinal (starts from 1) |
| tnf | pointer to variable containing TNF of record |
| type_record | pointer to array containing type of record |
| type_length | pointer to the variable containing length of type of record string |
| id | pointer to array containing ID of record |
| id_length | pointer to the variable containing length of ID of record string |
| payload | pointer to array containing payload of record |
| payload_length | pointer to the variable containing length of payload |
| card_formatted | pointer to the variable which shows that the card formatted for NDEF using. |

write_ndef_record_mirroring**Function description**

This function works the same as the **write_ndef_record()**, with the additional “UID and / or NFC counter mirror” features support. NTAG 21x family of the devices offers these specific features. For details about “ASCII mirror” features refer to http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 20) and http://www.nxp.com/docs/en/data-sheet/NTAG210_212.pdf (in Rev. 3.0 from 14. March 2013, page 16).

Function declaration (C language)

```
UFR_STATUS write_ndef_record_mirroring(uint8_t message_nr,
                                       uint8_t *tnf,
                                       uint8_t *type_record,
                                       uint8_t *type_length,
                                       uint8_t *id,
                                       uint8_t *id_length,
                                       uint8_t *payload,
                                       uint32_t *payload_length,
                                       uint8_t *card_formated,
                                       int use_uid_ascii_mirror,
                                       int use_counter_ascii_mirror,
                                       uint32_t payload_mirroring_pos);
```

Parameters

| | |
|---------------------------------|--|
| message_nr | NDEF message ordinal (starts from 1) |
| tnf | pointer to variable containing TNF of record |
| type_record | pointer to array containing type of record |
| type_length | pointer to the variable containing length of type of record string |
| id | pointer to array containing ID of record |
| id_length | pointer to the variable containing length of ID of record string |
| payload | pointer to array containing payload of record |
| payload_length | pointer to the variable containing length of payload |
| card_formated | pointer to the variable which shows that the card formatted for NDEF using. |
| use_uid_ascii_mirror | if use_uid_ascii_mirror == 1 then "UID ASCII Mirror" feature is in use. if use_uid_ascii_mirror == 0 then "UID ASCII Mirror" feature is switched off. |
| use_counter_ascii_mirror | if use_counter_ascii_mirror == 1 then "NFC counter ASCII Mirror" feature is in use. if use_counter_ascii_mirror == 0 then "NFC counter ASCII Mirror" feature is switched off. |
| payload_mirroring_pos | Defines the starting position of the "ASCII Mirror" in to the |

| | |
|--|----------------------|
| | NDEF record payload. |
|--|----------------------|

erase_last_ndef_record

Function description

Function deletes the last record of selected message. If message contains one record, then it will be written empty message.

Function declaration (C language)

```
UFR_STATUS erase_last_ndef_record(uint8_t message_nr) ;
```

Parameter

| | |
|-------------------|--------------------------------------|
| message_nr | NDEF message ordinal (starts form 1) |
|-------------------|--------------------------------------|

erase_all_ndef_records

Function description

Function deletes all records of message, then writes empty message.

Function declaration (C language)

```
UFR_STATUS erase_all_ndef_records(uint8_t message_nr) ;
```

Parameter

| | |
|-------------------|--------------------------------------|
| message_nr | NDEF message ordinal (starts form 1) |
|-------------------|--------------------------------------|

ndef_card_initialization

Function description

Function prepares the card for NDEF using. Function writes Capability Container (CC) if necessary, and writes empty message. If card is MIFARE CLASSIC or MIFARE PLUS, then function writes MAD (MIFARE Application Directory), and default keys and access bits for NDEF using.

Function declaration (C language)

```
UFR_STATUS ndef_card_initialization(void) ;
```

ERROR CODES OF NDEF FUNCTIONS

```
UFR_WRONG_NDEF_CARD_FORMAT = 0x80
```

```
UFR_NDEF_MESSAGE_NOT_FOUND = 0x81
```

```

UFR_NDEF_UNSUPPORTED_CARD_TYPE = 0x82
UFR_NDEF_CARD_FORMAT_ERROR = 0x83
UFR_MAD_NOT_ENABLED = 0x84
UFR_MAD_VERSION_NOT_SUPPORTED = 0x85

```

Functions for configuration of asynchronously card ID sending

When the card put on the reader, then the string which contains card ID shall be sent. String contains hexadecimal notation of card ID, after that is one mandatory suffix character. Before the card ID may be one prefix character placed.

Example:

Card ID is 0xA103C256, prefix is 0x58 ('X'), suffix is 0x59 ('Y')

String is "XA103C256Y"

SetAsyncCardIdSendConfig

Function description

Function sets the parameters of card ID sending. Parameters are: prefix existing, prefix character, suffix character, and baud rate for card ID sending.

Function declaration (C language)

```

UFR_STATUS SetAsyncCardIdSendConfig(uint8_t send_enable,
                                     uint8_t prefix_enable,
                                     uint8_t prefix,
                                     uint8_t suffix,
                                     uint32_t async_baud_rate);

```

Parameters

| | |
|------------------------|---|
| send_enable | sending enable flag (0 – disabled, 1 – enabled) |
| prefix_enable | prefix existing flag (0 – prefix don't exist, 1 – prefix exist) |
| prefix | prefix character |
| suffix | suffix character |
| async_baud_rate | baud rate value (e.g. 9600) |

GetAsyncCardIdSendConfig

Function description

Function returns the parameters of card ID sending.

Function declaration (C language)

```
UFR_STATUS GetAsyncCardIdSendConfig(uint8_t *send_enable,
                                     uint8_t *prefix_enable,
                                     uint8_t *prefix,
                                     uint8_t *suffix,
                                     uint32_t *async_baud_rate);
```

Parameters

| | |
|------------------------|-------------------------------------|
| send_enable | pointer to the sending enable flag |
| prefix_enable | pointer to the prefix existing flag |
| prefix | pointer to the prefix variable |
| suffix | pointer to the suffix variable |
| async_baud_rate | pointer to the baud rate variable |

Functions that works with Real Time Clock (RTC)

RTC embedded in uFR Advance device only.

GetReaderTime**Function description**

Function returns 6 bytes array of uint8_t that represented current date and time into device's RTC.

- Byte 0 represent year (current year – 2000)
- Byte 1 represent month (1 – 12)
- Byte 2 represent day of the month (1 – 31)
- Byte 3 represent hour (0 – 23)
- Byte 4 represent minute (0 – 59)
- Byte 5 represent second (0 – 59)

Function declaration (C language)

```
UFR_STATUS GetReaderTime(uint8_t *time);
```

Parameter

| | |
|-------------|--|
| time | pointer to the array containing current date and time representation |
|-------------|--|

SetReaderTime**Function description**

Function sets the date and time into device's RTC. Function requires the 8 bytes password entry to set date and time. Date and time are represent into 6 bytes array in same way as in GetReaderTime function. Factory password is "11111111" (0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31).

Function declaration (C language)

```
UFR_STATUS SetReaderTime(uint8_t *password,  
                          uint8_t *time);
```

Parameters

| | |
|-----------------|--|
| password | pointer to the 8 bytes array containing password |
| time | pointer to the 6 bytes array containing date and time representation |

ChangeReaderPassword**Function description**

Function changes password for set date and time. Function's parameters are old password and new password.

Function declaration (C language)

```
UFR_STATUS ChangeReaderPassword(uint8_t *old_password,  
                                uint8_t *new_password);
```

Parameters

| | |
|---------------------|--|
| old_password | pointer to the 8 bytes array containing current password |
| new_password | pointer to the 8 bytes array containing new password |

Functions that works with EEPROM

EEPROM embedded in uFR Advance device only.

Range of user address is from 0 to 32750.

ReaderEepromRead

Function description

Function returns array of data read from EEPROM. Maximal length of array is 128 bytes.

Function declaration (C language)

```
UFR_STATUS ReaderEepromRead(uint8_t *data,  
                             uint32_t address,  
                             uint32_t size);
```

Parameters

| | |
|----------------|--|
| data | pointer to array containing data from EEPROM |
| address | address of first data |
| size | length of array |

ReaderEepromWrite

Function description

Function writes array of data into EEPROM. Maximal length of array is 128 bytes. Function requires password which length is 8 bytes. Factory password is "11111111" (0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31).

Function declaration (C language)

```
UFR_STATUS ReaderEepromWrite(uint8_t *data,  
                              uint32_t address,  
                              uint32_t size,  
                              uint8_t *password);
```

Parameters

| | |
|-----------------|--------------------------------------|
| data | pointer to array containing data |
| address | address of first data |
| size | length of array |
| password | pointer to array containing password |

Functions that works with Mifare Desfire Card (AES encryption in reader)

AES encryption and decryption is performed in the reader. AES keys are stored into reader.

uFR_int_WriteAesKey

uFR_int_DesfireWriteKey

Function description

Function writes AES key (16 bytes) into reader.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireWriteAesKey(uint8_t aes_key_no,
                                       uint8_t *aes_key);
```

Parameters

| | |
|-------------------|--|
| aes_key_no | ordinal number of AES key in the reader (0 - 15) |
| aes_key | pointer to 16 byte array containing the AES key |

For uFR PLUS devices only

Function description

Function writes key into reader. There are 4 types of keys, and they enumerated

```
enum KEY_TYPE
{
    AES_KEY_TYPE = 0,    //AES 16 bytes
    DES3K_KEY_TYPE = 1,  //3K3DES 24 bytes
    DES_KEY_TYPE = 2,    //DES 8 bytes
    DES2K_KEY_TYPE = 3   //2K3DES 16 bytes
};
```

The 3K3DES key takes two fields into reader. For example if 3K3DES key stored at field 0, then the field 1 occupied. Next key may be stored into field 2.

```
UFR_STATUS uFR_int_DesfireWriteKey(uint8_t key_no,
                                    uint8_t *key,
                                    uint8_t key_type);
```

Parameters

| | |
|---------------|--|
| key_no | ordinal number of key in the reader (0 - 15) |
| key | pointer to array containing the key |

| | |
|-----------------|-----------------------------|
| key_type | enumerated key type (0 - 3) |
|-----------------|-----------------------------|

uFR_int_GetDesfireUid (deprecated)
uFR_int_GetDesfireUid_PK (deprecated)
uFR_int_GetDesfireUid_aes (alias for uFR_int_GetDesfireUid)
uFR_int_GetDesfireUid_des
uFR_int_GetDesfireUid_2k3des
uFR_int_GetDesfireUid_3k3des
uFR_int_GetDesfireUid_aes_PK (alias for uFR_int_GetDesfireUid_PK)
uFR_int_GetDesfireUid_des_PK
uFR_int_GetDesfireUid_2k3des_PK
uFR_int_GetDesfireUid_3k3des_PK
uFR_SAM_GetDesfireUidAesAuth
uFR_SAM_GetDesfireUidDesAuth
uFR_SAM_GetDesfireUid2k3desAuth
uFR_SAM_GetDesfireUid3k3desAuth

Function description

Mifare Desfire EV1 card can be configured to use Random ID numbers instead Unique ID numbers during anti-collision procedure. In this case card uses single anti-collision loop, and returns Random Number Tag 0x08 and 3 bytes Random Number (4 bytes Random ID). This function returns Unique ID of card, if the Random ID is used.

From library version 5.0.29. and firmware version 5.0.32, Desfire Light card supported.

Function declaration (C language)

```

UFR_STATUS uFR_int_GetDesfireUid(uint8_t aes_key_nr,
                                uint32_t aid,
                                uint8_t aid_key_nr,
                                uint8_t *card_uid,
                                uint8_t *card_uid_len,
                                uint16_t *card_status,
                                uint16_t *exec_time);

UFR_STATUS uFR_int_GetDesfireUid_PK(uint8_t *aes_key_ext,
                                    uint32_t aid,
                                    uint8_t aid_key_nr,
                                    uint8_t *card_uid,
                                    uint8_t *card_uid_len,
                                    uint16_t *card_status,
                                    uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.

```

UFR_STATUS uFR_int_GetDesfireUid_aes(uint8_t aes_key_nr,
                                     uint32_t aid,
                                     uint8_t aid_key_nr,
                                     uint8_t *card_uid,
                                     uint8_t *card_uid_len,
                                     uint16_t *card_status,
                                     uint16_t *exec_time);

UFR_STATUS uFR_int_GetDesfireUid_des(uint8_t des_key_nr,
                                     uint32_t aid,
                                     uint8_t aid_key_nr,
                                     uint8_t *card_uid,
                                     uint8_t *card_uid_len,
                                     uint16_t *card_status,
                                     uint16_t *exec_time);

UFR_STATUS uFR_int_GetDesfireUid_2k3des(uint8_t des2k_key_nr,
                                     uint32_t aid,
                                     uint8_t aid_key_nr,
                                     uint8_t *card_uid,
                                     uint8_t *card_uid_len,
                                     uint16_t *card_status,
                                     uint16_t *exec_time);

UFR_STATUS uFR_int_GetDesfireUid_3k3des(uint8_t des3k_key_nr,
                                     uint32_t aid,
                                     uint8_t aid_key_nr,
                                     uint8_t *card_uid,
                                     uint8_t *card_uid_len,
                                     uint16_t *card_status,
                                     uint16_t *exec_time);

UFR_STATUS uFR_int_GetDesfireUid_aes_PK(uint8_t *aes_key_ext,
                                     uint32_t aid,
                                     uint8_t aid_key_nr,
                                     uint8_t *card_uid,
                                     uint8_t *card_uid_len,
                                     uint16_t *card_status,
                                     uint16_t *exec_time);

UFR_STATUS uFR_int_GetDesfireUid_des_PK(uint8_t *des_key_ext,
                                     uint32_t aid,
                                     uint8_t aid_key_nr,
                                     uint8_t *card_uid,
                                     uint8_t *card_uid_len,
                                     uint16_t *card_status,
                                     uint16_t *exec_time);

```



```

UFR_STATUS uFR_int_GetDesfireUid_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t *card_uid,
    uint8_t *card_uid_len,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_GetDesfireUid_3k3des_PK(
    uint8_t *des3k_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t *card_uid,
    uint8_t *card_uid_len,
    uint16_t *card_status,
    uint16_t *exec_time);

*only uFR CS with SAM support

UFR_STATUS uFR_SAM_GetDesfireUidAesAuth(uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t *card_uid,
    uint8_t *card_uid_len,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_GetDesfireUidDesAuth(uint8_t des_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t *card_uid,
    uint8_t *card_uid_len,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_GetDesfireUid2k3desAuth(uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t *card_uid,
    uint8_t *card_uid_len,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_GetDesfireUid3k3desAuth(uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t *card_uid,
    uint8_t *card_uid_len,
    uint16_t *card_status,
    uint16_t *exec_time);

```

Parameters

| | | | | | | | | |
|------------|---------|--------|----|-----|-----|----|-----|--------|
| aes_key_nr | ordinal | number | of | AES | key | in | the | reader |
|------------|---------|--------|----|-----|-----|----|-----|--------|

| | |
|----------------------|---|
| des_key_nr | ordinal number of DES key in the reader |
| des2k_key_nr | ordinal number of 2K3DES key in the reader |
| des3k_key_nr | ordinal number of 3K3DES key in the reader |
| aes_key_ext | pointer to 16 bytes array containing the AES key |
| des_key_ext | pointer to 8 bytes array containing the DES key |
| des2k_key_ext | pointer to 16 bytes array containing the 2K3DES key |
| des3k_key_ext | pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that uses this key (3 bytes long, 0x000000 for card master key) |
| aid_key_nr | key number into application (0 for card master key or application master key) |
| card_uid | pointer to array containing card UID |
| card_uid_len | pointer to card UID length variable |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireFreeMem

Function description

Function returns the available bytes on the card.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireFreeMem(uint32_t *free_mem_byte,
                                   uint16_t *card_status,
                                   uint16_t *exec_time);
```

Parameters

| | |
|----------------------|--------------------------------------|
| free_mem_byte | pointer to free memory size variable |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireFormatCard (deprecated)
uFR_int_DesfireFormatCard_PK (deprecated)
uFR_int_DesfireFormatCard_aes (alias for uFR_int_DesfireFormatCard)
uFR_int_DesfireFormatCard_des
uFR_int_DesfireFormatCard_2k3des
uFR_int_DesfireFormatCard_3k3des
uFR_int_DesfireFormatCard_aes_PK (alias for uFR_int_DesfireFormatCard_PK)
uFR_int_DesfireFormatCard_des_PK
uFR_int_DesfireFormatCard_2k3des_PK
uFR_int_DesfireFormatCard_3k3des_PK
uFR_SAM_DesfireFormatCardAesAuth
uFR_SAM_DesfireFormatCardDesAuth
uFR_SAM_DesfireFormatCard2k3desAuth
uFR_SAM_DesfireFormatCard3k3desAuth

Function description

Function releases all allocated user memory on the card. All applications will be deleted, also all files within those applications will be deleted. Only the card master key, and card master key settings will not be deleted. This operation requires authentication with the card master key.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireFormatCard(uint8_t aes_key_nr,  
                                     uint16_t *card_status,  
                                     uint16_t *exec_time);  
UFR_STATUS uFR_int_DesfireFormatCard_PK(uint8_t *aes_key_ext,  
                                         uint16_t *card_status,  
                                         uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```

UFR_STATUS uFR_int_DesfireFormatCard_aes(
    uint8_t aes_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireFormatCard_des(
    uint8_t des_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireFormatCard_2k3des(
    uint8_t des2k_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireFormatCard_3k3des(
    uint8_t des3k_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireFormatCard_aes_PK(
    uint8_t *aes_key_ext,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireFormatCard_des_PK(
    uint8_t *des_key_ext,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireFormatCard_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireFormatCard_3k3des_PK(
    uint8_t *des3k_key_ext,
    uint16_t *card_status,
    uint16_t *exec_time);

*only uFR CS with SAM support

UFR_STATUS uFR_SAM_DesfireFormatCardAesAuth(
    uint8_t aes_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireFormatCardDesAuth(
    uint8_t des_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireFormatCard2k3desAuth(
    uint8_t des2k_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireFormatCard3k3desAuth(
    uint8_t des3k_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

```

Parameters

| | |
|----------------------|---|
| aes_key_nr | ordinal number of AES key in the reader |
| des_key_nr | ordinal number of DES key in the reader |
| des2k_key_nr | ordinal number of 2K3DES key in the reader |
| des3k_key_nr | ordinal number of 3K3DES key in the reader |
| aes_key_ext | pointer to 16 bytes array containing the AES key |
| des_key_ext | pointer to 8 bytes array containing the DES key |
| des2k_key_ext | pointer to 16 bytes array containing the 2K3DES key |
| des3k_key_ext | pointer to 24 bytes array containing the 3K3DES key |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

*uFR_int_DesfireSetConfiguration (deprecated)**uFR_int_DesfireSetConfiguration_PK (deprecated)**uFR_int_DesfireSetConfiguration_aes (alias for uFR_int_DesfireSetConfiguration)**uFR_int_DesfireSetConfiguration_des**uFR_int_DesfireSetConfiguration_2k3des**uFR_int_DesfireSetConfiguration_3k3des**uFR_int_DesfireSetConfiguration_aes_PK (alias for uFR_int_DesfireSetConfiguration_PK)**uFR_int_DesfireSetConfiguration_des_PK**uFR_int_DesfireSetConfiguration_2k3des_PK**uFR_int_DesfireSetConfiguration_3k3des_PK**uFR_SAM_DesfireSetConfigurationAesAuth**uFR_SAM_DesfireSetConfigurationDesAuth**uFR_SAM_DesfireSetConfiguration2k3desAuth**uFR_SAM_DesfireSetConfiguration3k3desAuth***Function description**

Function allows you to activate the Random ID option, and/or Format disable option.

If these options are activated, then they can not be returned to the factory setting (Random ID disabled, Format card enabled). This operation requires authentication with the card master key.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireSetConfiguration(uint8_t aes_key_nr,  
                                            uint8_t random_uid,  
                                            uint8_t format_disable,  
                                            uint16_t *card_status,  
                                            uint16_t *exec_time);  
UFR_STATUS uFR_int_DesfireSetConfiguration_PK(uint8_t *aes_key_ext,  
                                              uint8_t random_uid,  
                                              uint8_t format_disable,  
                                              uint16_t *card_status,  
                                              uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```

UFR_STATUS uFR_int_DesfireSetConfiguration_aes(
    uint8_t aes_key_nr,
    uint8_t random_uid,
    uint8_t format_disable,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireSetConfiguration_des(
    uint8_t des_key_nr,
    uint8_t random_uid,
    uint8_t format_disable,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireSetConfiguration_2k3des(
    uint8_t des2k_key_nr,
    uint8_t random_uid,
    uint8_t format_disable,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireSetConfiguration_3k3des(
    uint8_t des3k_key_nr,
    uint8_t random_uid,
    uint8_t format_disable,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireSetConfiguration_aes_PK(
    uint8_t *aes_key_ext,
    uint8_t random_uid,
    uint8_t format_disable,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireSetConfiguration_des_PK(
    uint8_t *des_key_ext,
    uint8_t random_uid,
    uint8_t format_disable,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireSetConfiguration_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint8_t random_uid,
    uint8_t format_disable,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireSetConfiguration_3k3des_PK(
    uint8_t *des3k_key_ext,
    uint8_t random_uid,
    uint8_t format_disable,
    uint16_t *card_status,
    uint16_t *exec_time);

```

*only uFR CS with SAM support

```
UFR_STATUS uFR_SAM_DesfireSetConfigurationAesAuth(
```

```

uint8_t aes_key_nr,
uint8_t random_uid,
uint8_t format_disable,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireSetConfigurationDesAuth(
uint8_t des_key_nr,
uint8_t random_uid,
uint8_t format_disable,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireSetConfiguration2k3desAuth(
uint8_t des2k_key_nr,
uint8_t random_uid,
uint8_t format_disable,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireSetConfiguration3k3desAuth(
uint8_t des3k_key_nr,
uint8_t random_uid,
uint8_t format_disable,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| random_uid | 0 – Random ID disabled, 1 – Random ID enabled |
| format_disable | 0 – Format enabled, 1 – Format disabled |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireGetKeySettings (deprecated)
uFR_int_DesfireGetKeySettings_PK (deprecated)
uFR_int_DesfireGetKeySettings_aes (alias for uFR_int_DesfireGetKeySettings)
uFR_int_DesfireGetKeySettings_des
uFR_int_DesfireGetKeySettings_2k3des
uFR_int_DesfireGetKeySettings_3k3des
uFR_int_DesfireGetKeySettings_aes_PK (alias for uFR_int_DesfireGetKeySettings_PK)
uFR_int_DesfireGetKeySettings_des_PK
uFR_int_DesfireGetKeySettings_2k3des_PK
uFR_int_DesfireGetKeySettings_3k3des_PK
uFR_SAM_DesfireGetKeySettingsAesAuth
uFR_SAM_DesfireGetKeySettingsDesAuth
uFR_SAM_DesfireGetKeySettings2k3desAuth
uFR_SAM_DesfireGetKeySettings3k3desAuth

Function description

Function allows to get card master key and application master key configuration settings. In addition it returns the maximum number of keys which can be stored within selected application.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireGetKeySettings(uint8_t aes_key_nr,
                                         uint32_t aid,
                                         uint8_t *settings
                                         uint8_t *max_key_no,
                                         uint16_t *card_status,
                                         uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetKeySettings_PK(uint8_t *aes_key_ext,
                                             uint32_t aid,
                                             uint8_t *settings
                                             uint8_t *max_key_no,
                                             uint16_t *card_status,
                                             uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.

```

UFR_STATUS uFR_int_DesfireGetKeySettings_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetKeySettings_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetKeySettings_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetKeySettings_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetKeySettings_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetKeySettings_des_PK(
    uint8_t *des_key_ext,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

```

```

UFR_STATUS uFR_int_DesfireGetKeySettings_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetKeySettings_3k3des_PK(
    uint8_t *des3k_key_ext,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

```

*only uFR CS with SAM support

```

UFR_STATUS uFR_SAM_DesfireGetKeySettingsAesAuth(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireGetKeySettingsDesAuth(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireGetKeySettings2k3desAuth(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireGetKeySettings3k3desAuth(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t *setting,
    uint8_t *max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

```

Parameters

| | | | | | | | | |
|------------|---------|--------|----|-----|-----|----|-----|--------|
| aes_key_nr | ordinal | number | of | AES | key | in | the | reader |
| des_key_nr | ordinal | number | of | DES | key | in | the | reader |

| | |
|--|---|
| des2k_key_nr des3k_key_nr | ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that uses this key (3 bytes long, 0x000000 for card master key) |
| settings | pointer to settings variable |
| max_key_no | maximum number of keys within selected application |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireChangeKeySettings (deprecated)

uFR_int_DesfireChangeKeySettings_PK (deprecated)

uFR_int_DesfireChangeKeySettings_aes (alias for uFR_int_DesfireChangeKeySettings)

uFR_int_DesfireChangeKeySettings_des

uFR_int_DesfireChangeKeySettings_2k3des

uFR_int_DesfireChangeKeySettings_3k3des

uFR_int_DesfireChangeKeySettings_aes_PK (alias for uFR_int_DesfireChangeKeySettings_PK)

uFR_int_DesfireChangeKeySettings_des_PK

uFR_int_DesfireChangeKeySettings_2k3des_PK

uFR_int_DesfireChangeKeySettings_3k3des_PK

uFR_SAM_DesfireChangeKeySettingsAesAuth

uFR_SAM_DesfireChangeKeySettingsDesAuth

uFR_SAM_DesfireChangeKeySettings2k3desAuth

uFR_SAM_DesfireChangeKeySettings3k3desAuth

Function description

Function allows to set card master key, and application master key configuration settings.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireChangeKeySettings(uint8_t aes_key_nr,
                                             uint32_t aid,
                                             uint8_t settings,
                                             uint16_t *card_status,
                                             uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeKeySettings_PK(uint8_t *aes_key_ext,
                                                uint32_t aid,
                                                uint8_t settings,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.

```

UFR_STATUS uFR_int_DesfireChangeKeySettings_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeKeySettings_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeKeySettings_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeKeySettings_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeKeySettings_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeKeySettings_des_PK(
    uint8_t *des_key_ext,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);

```

```
UFR_STATUS uFR_int_DesfireChangeKeySettings_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireChangeKeySettings_3k3des_PK(
    uint8_t *des3k_key_ext,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);
```

*only uFR CS with SAM support

```
UFR_STATUS uFR_SAM_DesfireChangeKeySettingsAesAuth(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```
UFR_STATUS uFR_SAM_DesfireChangeKeySettingsDesAuth(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```
UFR_STATUS uFR_SAM_DesfireChangeKeySettings2k3desAuth(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```
UFR_STATUS uFR_SAM_DesfireChangeKeySettings3k3desAuth(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint16_t *card_status,
    uint16_t *exec_time);
```

Parameters

| | |
|---------------|---|
| aes_key_nr | ordinal number of AES key in the reader |
| des_key_nr | ordinal number of DES key in the reader |
| des2k_key_nr | ordinal number of 2K3DES key in the reader |
| des3k_key_nr | ordinal number of 3K3DES key in the reader |
| aes_key_ext | pointer to 16 bytes array containing the AES key |
| des_key_ext | pointer to 8 bytes array containing the DES key |
| des2k_key_ext | pointer to 16 bytes array containing the 2K3DES key |
| | pointer to 24 bytes array containing the 3K3DES key |

| | |
|----------------------|---|
| des3k_key_ext | |
| aid | ID of application that uses this key (3 bytes long, 0x000000 for card master key) |
| settings | pointer to key settings variable |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireChangeAesKey
uFR_int_DesfireChangeAesKey_PK (deprecated)
uFR_int_DesfireChangeAesKey_A (deprecated)
uFR_int_DesfireChangeAesKey_aes (alias for uFR_int_DesfireChangeAesKey_A)
uFR_int_DesfireChangeDesKey_des
uFR_int_DesfireChange2K3DesKey_des
uFR_int_DesfireChangeDesKey_2k3des
uFR_int_DesfireChange2K3DesKey_2k3des
uFR_int_DesfireChange3K3DesKey_3k3des
uFR_int_DesfireChangeMasterKey
uFR_int_DesfireChangeAesKey_aes_PK (alias for uFR_int_DesfireChangeAesKey_PK)
uFR_int_DesfireChangeDesKey_des_PK
uFR_int_DesfireChange2K3DesKey_des_PK
uFR_int_DesfireChangeDesKey_2k3des_PK
uFR_int_DesfireChange2K3DesKey_2k3des_PK
uFR_int_DesfireChange3K3DesKey_3k3des_PK
uFR_int_DesfireChangeMasterKey_PK
uFR_SAM_DesfireChangeAesKey_AesAuth
uFR_SAM_DesfireChangeDesKey_DesAuth
uFR_SAM_DesfireChange2k3desKey_DesAuth
uFR_SAM_DesfireChangeDesKey_2k3desAuth
uFR_SAM_DesfireChange2k3desKey_2k3desAuth
uFR_SAM_DesfireChange3k3desKey_3k3desAuth
uFR_SAM_DesfireChangeMasterKey

Function description

Function allow to change any AES key on the card. Changing the card master key require current card master key authentication. Authentication for the application keys changing depend on the application master key settings (which key uses for authentication).

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireChangeAesKey(uint8_t aes_key_nr,
                                         uint32_t aid,
                                         uint8_t aid_key_nr_auth,
                                         uint8_t new_aes_key[16],
                                         uint8_t aid_key_no,
                                         uint8_t old_aes_key[16],
                                         uint16_t *card_status,
                                         uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeAesKey_PK(uint8_t *aes_key_ext,
                                           uint32_t aid,
                                           uint8_t aid_key_nr_auth,
                                           uint8_t new_aes_key[16],
                                           uint8_t aid_key_no,
                                           uint8_t old_aes_key[16],
                                           uint16_t *card_status,
                                           uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeAesKey_A(uint8_t aes_key_nr,
                                           uint32_t aid,
                                           uint8_t aid_key_no_auth,
                                           uint8_t new_aes_key_nr,
                                           uint8_t aid_key_no,
                                           uint8_t old_aes_key_nr,
                                           uint16_t *card_status,
                                           uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.


```

UFR_STATUS uFR_int_DesfireChangeAesKey_aes(uint8_t aes_key_nr,
                                           uint32_t aid,
                                           uint8_t aid_key_no_auth,
                                           uint8_t new_aes_key_nr,
                                           uint8_t aid_key_no,
                                           uint8_t old_aes_key_nr,
                                           uint16_t *card_status,
                                           uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeDesKey_des(
    uint8_t auth_des_key_nr,
    uint32_t aid,
    uint8_t aid_key_no_auth,
    uint8_t new_des_key_nr,
    uint8_t aid_key_no,
    uint8_t old_des_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChange2K3DesKey_des(
    uint8_t auth_des_key_nr,
    uint32_t aid,
    uint8_t aid_key_no_auth,
    uint8_t new_2k3des_key_nr,
    uint8_t aid_key_no,
    uint8_t old_2k3des_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeDesKey_2k3des(
    uint8_t auth_des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_no_auth,
    uint8_t new_des_key_nr,
    uint8_t aid_key_no,
    uint8_t old_des_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChange2K3DesKey_2k3des(
    uint8_t auth_des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_no_auth,
    uint8_t new_2k3des_key_nr,
    uint8_t aid_key_no,
    uint8_t old_2k3des_key_nr,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChange3K3DesKey_3k3des(
    uint8_t auth_des3k_key_nr,
    uint32_t aid,
    uint8_t aid_key_no_auth,
    uint8_t new_3k3des_key_nr,
    uint8_t aid_key_no,

```

```

uint8_t old_3k3des_key_nr,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeMasterKey(
uint8_t auth_key_nr,
uint8_t auth_key_type,
uint8_t new_key_nr,
uint8_t new_key_type,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeAesKey_aes_PK(uint8_t *aes_key_ext,
uint32_t aid,
uint8_t aid_key_nr_auth,
uint8_t new_aes_key[16],
uint8_t aid_key_no,
uint8_t old_aes_key[16],
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeDesKey_des_PK(
uint8_t *auth_des_key,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_des_key[8],
uint8_t aid_key_no,
uint8_t old_des_key[8],
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChange2K3DesKey_des_PK(
uint8_t *auth_des_key,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_2k3des_key[16],
uint8_t aid_key_no,
uint8_t old_2k3des_key[16],
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeDesKey_2k3des_PK(
uint8_t *auth_des2k_key,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_des_key[8],
uint8_t aid_key_no,
uint8_t old_des_key[8],
uint16_t *card_status,
VAR uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChange2K3DesKey_2k3des_PK(
uint8_t *auth_des2k_key,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_2k3des_key[16],
uint8_t aid_key_no,

```

```

uint8_t old_2k3des_key[16],
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChange3K3DesKey_3k3des_PK(
uint8_t *auth_des3k_key,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_3k3des_key[24],
uint8_t aid_key_no,
uint8_t old_3k3des_key[24],
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireChangeMasterKey_PK(
uint8_t *auth_key,
uint8_t auth_key_type,
uint8_t *new_key,
uint8_t new_key_type,
uint16_t *card_status,
uint16_t *exec_time);

*only uFR CS with SAM support

UFR_STATUS uFR_SAM_DesfireChangeAesKey_AesAuth(uint8_t aes_key_nr,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_aes_key_nr,
uint8_t aid_key_no,
uint8_t old_aes_key_nr,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireChangeDesKey_DesAuth(
uint8_t auth_des_key_nr,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_des_key_nr,
uint8_t aid_key_no,
uint8_t old_des_key_nr,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireChange2k3desKey_DesAuth(
uint8_t auth_des_key_nr,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_2k3des_key_nr,
uint8_t aid_key_no,
uint8_t old_2k3des_key_nr,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireChangeDesKey_2k3desAuth(
uint8_t auth_des2k_key_nr,
uint32_t aid,
uint8_t aid_key_no_auth,

```

```

uint8_t new_des_key_nr,
uint8_t aid_key_no,
uint8_t old_des_key_nr,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireChange2k3desKey_2k3desAuth(
uint8_t auth_des2k_key_nr,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_2k3des_key_nr,
uint8_t aid_key_no,
uint8_t old_2k3des_key_nr,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireChange3k3desKey_3k3desAuth(
uint8_t auth_des3k_key_nr,
uint32_t aid,
uint8_t aid_key_no_auth,
uint8_t new_3k3des_key_nr,
uint8_t aid_key_no,
uint8_t old_3k3des_key_nr,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireChangeMasterKey(
uint8_t auth_key_nr,
uint8_t auth_key_type,
uint8_t new_key_nr,
uint8_t new_key_type,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|--|
| aes_key_nr auth_des_key_nr auth_des2k_key auth_des3k_key_nr | ordinal number of authentication AES key in the reader ordinal number of authentication DES key in the reader ordinal number of authentication 2K3DES key in the reader ordinal number of authentication 3K3DES key in the reader |
| aes_key_ext auth_des_key auth_des2k_key auth_des3k_key | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 32 bytes array containing the 3K3DES key |
| aid | ID of application that uses this key (3 bytes long, 0x000000 for card master key) |
| aid_key_nr_auth | key number into application which uses for authentication |

| | |
|---|---|
| new_aes_key[16] new_des_key[8] new_2k3des_key[16] new_3k3des_key[24] | 16 bytes array that represent AES key 8 bytes array that represent DES key 16 bytes array that represent 2K3DES key 24 bytes array that represent 3K3DES key |
| aid_key_no | key number into application that will be changed |
| old_aes_key[16] old_des_key[8] old_2k3des_key[16] old_3k3des_key[24] | 16 bytes array that represent current AES key that will be changed, if this is not key by which is made authentication |
| auth_key_type new_key_type | AES_KEY_TYPE = 0, //AES 16 bytes DES3K_KEY_TYPE = 1, //3K3DES 24 bytes DES_KEY_TYPE = 2, //DES 8 bytes DES2K_KEY_TYPE = 3 //2K3DES 16 bytes |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireCreateAesApplication (deprecated)
uFR_int_DesfireCreateAesApplication_PK (deprecated)
uFR_int_DesfireCreateAesApplication_no_auth
uFR_int_DesfireCreateAesApplication_aes (alias for uFR_int_DesfireCreateAesApplication)
uFR_int_DesfireCreateDesApplication_aes
uFR_int_DesfireCreate3k3desApplication_aes
uFR_int_DesfireCreateAesApplication_des
uFR_int_DesfireCreateDesApplication_des
uFR_int_DesfireCreate3k3desApplication_des
uFR_int_DesfireCreateAesApplication_2k3des
uFR_int_DesfireCreateDesApplication_2k3des
uFR_int_DesfireCreate3k3desApplication_2k3des
uFR_int_DesfireCreateAesApplication_3k3des
uFR_int_DesfireCreateDesApplication_3k3des
uFR_int_DesfireCreate3k3desApplication_3k3des
uFR_int_DesfireCreateAesApplication_aes_PK (alias for FR_int_DesfireCreateAesApplication_PK)
uFR_int_DesfireCreateDesApplication_aes_PK
uFR_int_DesfireCreate3k3desApplication_aes_PK
uFR_int_DesfireCreateAesApplication_des_PK
uFR_int_DesfireCreateDesApplication_des_PK
uFR_int_DesfireCreate3k3desApplication_des_PK
uFR_int_DesfireCreateAesApplication_2k3des_PK
uFR_int_DesfireCreateDesApplication_2k3des_PK
uFR_int_DesfireCreate3k3desApplication_2k3des_PK
uFR_int_DesfireCreateAesApplication_3k3des_PK
uFR_int_DesfireCreateDesApplication_3k3des_PK
uFR_int_DesfireCreate3k3desApplication_3k3des_PK
uFR_SAM_DesfireCreateAesApplicationAesAuth
uFR_SAM_DesfireCreateDesApplicationAesAuth
uFR_SAM_DesfireCreate3k3desApplicationAesAuth
uFR_SAM_DesfireCreateAesApplicationDesAuth
uFR_SAM_DesfireCreateDesApplicationDesAuth
uFR_SAM_DesfireCreate3k3desApplicationDesAuth
uFR_SAM_DesfireCreateAesApplication2k3desAuth
uFR_SAM_DesfireCreateDesApplication2k3desAuth
uFR_SAM_DesfireCreate3k3desApplication2k3desAuth
uFR_SAM_DesfireCreateAesApplication3k3desAuth
uFR_SAM_DesfireCreateDesApplication3k3desAuth
uFR_SAM_DesfireCreate3k3desApplication3k3desAuth

Function description

Function allows to create a new application on the card. Is the card master key authentication is required, depending on the card master key settings. Maximal number of applications on the card is 28. Each application is linked to set of up 14 different user definable access keys.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireCreateAesApplication(uint8_t aes_key_nr,
                                                uint32_t aid_nr,
                                                uint8_t setting,
                                                uint8_t max_key_no,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateAesApplication_PK(
                                                uint8_t *aes_key_ext,
                                                uint32_t aid,
                                                uint8_t setting,
                                                uint8_t max_key_no,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateAesApplication_no_auth(
                                                uint32_t aid,
                                                uint8_t setting,
                                                uint8_t max_key_no,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireCreateAesApplication_aes(uint8_t aes_key_nr,
                                                    uint32_t aid_nr,
                                                    uint8_t setting,
                                                    uint8_t max_key_no,
                                                    uint16_t *card_status,
                                                    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreate3k3desApplication_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateDesApplication_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateAesApplication_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);
```



```

UFR_STATUS uFR_int_DesfireCreate3k3desApplication_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateDesApplication_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateAesApplication_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreate3k3desApplication_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateDesApplication_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateAesApplication_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreate3k3desApplication_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateDesApplication_des(
    uint8_t des_key_nr,

```

```

uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_aes_PK(
uint8_t *aes_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_aes_PK(
uint8_t *aes_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_aes_PK(
uint8_t *aes_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_2k3des_PK(
uint8_t *des2k_key_ext,
uint32_t aid,
uint8_t setting,

```

```

uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_2k3des_PK(
uint8_t *des2k_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_2k3des_PK(
uint8_t *des2k_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_des_PK(
uint8_t *des_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_des_PK(
IN uint8_t *des_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
VAR uint16_t *card_status,
VAR uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_des_PK(
IN uint8_t *des_key_ext,
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
VAR uint16_t *card_status,
VAR uint16_t *exec_time);

*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireCreateAesApplicationAesAuth(
uint8_t aes_key_nr,
uint32_t aid_nr,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateDesApplicationAesAuth(
uint8_t aes_key_nr,
uint32_t aid,
uint8_t setting,

```

```
uint8_t max_key_no,  
uint16_t *card_status,  
uint16_t *exec_time);  
UFR_STATUS uFR_SAM_DesfireCreate3k3desApplicationAesAuth(  
uint8_t aes_key_nr,  
uint32_t aid,  
uint8_t setting,  
uint8_t max_key_no,  
uint16_t *card_status,  
uint16_t *exec_time);  
UFR_STATUS uFR_SAM_DesfireCreateAesApplicationDesAuth(  
uint8_t des_key_nr,  
uint32_t aid,  
uint8_t setting,  
uint8_t max_key_no,  
uint16_t *card_status,  
uint16_t *exec_time);
```

```

UFR_STATUS uFR_SAM_DesfireCreateDesApplicationDesAuth(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreate3k3desApplicationDesAuth(
    uint8_t desk_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreateAesApplication2k3desAuth(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreateDesApplication2k3desAuth(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreate2k3desApplication2k3desAuth(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreateAesApplication3k3desAuth(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreateDesApplication3k3desAuth(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t setting,
    uint8_t max_key_no,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreate3k3desApplication3k3desAuth(
    uint8_t des3k_key_nr,

```

```
uint32_t aid,
uint8_t setting,
uint8_t max_key_no,
uint16_t *card_status,
uint16_t *exec_time);
```

Parameter

| | |
|----------------------|--|
| aes_key_nr | ordinal number of AES key in the reader |
| des_key_nr | ordinal number of DES key in the reader |
| des2k_key_nr | ordinal number of 2K3DES key in the reader |
| des3k_key_nr | ordinal number of 3K3DES key in the reader |
| aes_key_ext | pointer to 16 bytes array containing the AES key |
| des_key_ext | pointer to 8 bytes array containing the DES key |
| des2k_key_ext | pointer to 16 bytes array containing the 2K3DES key |
| des3k_key_ext | pointer to 24 bytes array containing the 3K3DES key |
| aid_nr | ID of application that creates (3 bytes long 0x000000 to 0xFFFFFFFF) |
| settings | application master key settings |
| max_key_no | maximal number of keys into application (1 to 14) |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireDeleteApplication (deprecated)
uFR_int_DesfireDeleteApplication_PK (deprecated)
uFR_int_DesfireDeleteApplication_aes (alias for uFR_int_DesfireDeleteApplication)
uFR_int_DesfireDeleteApplication_des
uFR_int_DesfireDeleteApplication_2k3des
uFR_int_DesfireDeleteApplication_3k3des
uFR_int_DesfireDeleteApplication_aes_PK (alias for uFR_int_DesfireDeleteApplication_PK)
uFR_int_DesfireDeleteApplication_des_PK
uFR_int_DesfireDeleteApplication_2k3des_PK
uFR_int_DesfireDeleteApplication_3k3des_PK
uFR_SAM_DesfireDeleteApplicationAesAuth
uFR_SAM_DesfireDeleteApplicationDesAuth
uFR_SAM_DesfireDeleteApplication2k3desAuth
uFR_SAM_DesfireDeleteApplication3k3desAuth

Function description

Function allows to deactivate application on the card. Is the card master key authentication is required, depending on the card master key settings. AID allocation is removed, but deleted memory blocks can only recovered by using Format card function.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireDeleteApplication(uint8_t aes_key_nr,
                                             uint32_t aid_nr,
                                             uint16_t *card_status,
                                             uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteApplication_PK(uint8_t *aes_key_ext,
                                                uint32_t aid_nr,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.

```

UFR_STATUS uFR_int_DesfireDeleteApplication_aes(uint8_t aes_key_nr,
                                                uint32_t aid_nr,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteApplication_des(
                                                uint8_t des_key_nr,
                                                uint32_t aid,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteApplication_2k3des(
                                                uint8_t des2k_key_nr,
                                                uint32_t aid,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteApplication_3k3des(
                                                uint8_t des3k_key_nr,
                                                uint32_t aid,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteApplication_aes_PK(
                                                uint8_t *aes_key_ext,
                                                uint32_t aid,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteApplication_des_PK(
                                                uint8_t *des_key_ext,
                                                uint32_t aid,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteApplication_2k3des_PK(
                                                uint8_t *des2k_key_ext,
                                                uint32_t aid,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteApplication_3k3des_PK(
                                                uint8_t *des3k_key_ext,
                                                uint32_t aid,
                                                uint16_t *card_status,
                                                uint16_t *exec_time);

*only uFR CS with SAM support

UFR_STATUS uFR_SAM_DesfireDeleteApplicationAesAuth(uint8_t aes_key_nr,
                                                    uint32_t aid_nr,
                                                    uint16_t *card_status,
                                                    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireDeleteApplicationDesAuth(
                                                    uint8_t des_key_nr,
                                                    uint32_t aid,
                                                    uint16_t *card_status,
                                                    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireDeleteApplication2k3desAuth(

```



```

uint8_t des2k_key_nr,
uint32_t aid,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDeleteApplication3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid_nr | ID of application that deletes (3 bytes long 0x000000 to 0xFFFFFFFF) |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireCreateStdDataFile (deprecated)
uFR_int_DesfireCreateStdDataFile_PK (deprecated)
uFR_int_DesfireCreateStdDataFile_no_auth
uFR_int_DesfireCreateStdDataFile_aes (alias for uFR_int_DesfireCreateStdDataFile)
uFR_int_DesfireCreateStdDataFile_des
uFR_int_DesfireCreateStdDataFile_2k3des
uFR_int_DesfireCreateStdDataFile_3k3des
uFR_int_DesfireCreateStdDataFile_aes_PK (alias for uFR_int_DesfireCreateStdDataFile_PK)
uFR_int_DesfireCreateStdDataFile_des_PK
uFR_int_DesfireCreateStdDataFile_2k3des_PK
uFR_int_DesfireCreateStdDataFile_3k3des_PK
uFR_SAM_DesfireCreateStdDataFileAesAuth
uFR_SAM_DesfireCreateStdDataFileDesAuth
uFR_SAM_DesfireCreateStdDataFile2k3desAuth
uFR_SAM_DesfireCreateStdDataFile3k3desAuth

Function description

Function allows to create file for the storage unformatted user data within existing application on the card. Maximal number of files into application is 32. The file will be created in the currently selected application. Is the application master key authentication is required, depend on the application master key settings. Communication settings define communication mode between reader and card. The communication modes are:

- plain communication communication settings value is 0x00
- plain communication secured by MACing communication settings value is 0x01
- fully enciphered communication communication settings value is 0x03

Access rights for read, write, read&write and changing, references certain key within application's keys (0 – 13). If value is 14, this means free access, independent of previous authentication. If value is 15, this means deny access (for example if write access is 15 then the file type is read only).

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireCreateStdDataFile(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint32_t file_size,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateStdDataFile_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t file_id,
    uint32_t file_size,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateStdDataFile_no_auth(
    uint32_t aid,
    uint8_t file_id,
    uint32_t file_size,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.

```

UFR_STATUS uFR_int_DesfireCreateStdDataFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint32_t file_size,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateStdDataFile_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint32_t file_size,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateStdDataFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint32_t file_size,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateStdDataFile_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint32_t file_size,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateStdDataFile_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,

```

```

uint8_t file_id,
uint32_t file_size,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateStdDataFile_des_PK(
uint8_t *des_key_ext,
uint32_t aid,
uint8_t file_id,
uint32_t file_size,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateStdDataFile_2k3des_PK(
uint8_t *des2k_key_ext,
uint32_t aid,
uint8_t file_id,
uint32_t file_size,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateStdDataFile_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,
uint8_t file_id,
uint32_t file_size,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

*only uFR CS with SAM support

UFR_STATUS uFR_SAM_DesfireCreateStdDataFileAesAuth(
uint8_t aes_key_nr,
uint32_t aid,
uint8_t file_id,

```

```

uint32_t file_size,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreateStdDataFileDesAuth(
uint8_t des_key_nr,
uint32_t aid,
uint8_t file_id,
uint32_t file_size,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreateStdDataFile2k3desAuth(
uint8_t des2k_key_nr,
uint32_t aid,
uint8_t file_id,
uint32_t file_size,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreateStdDataFile3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint8_t file_id,
uint32_t file_size,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | | | | | | | | |
|------------|---------|--------|----|-----|-----|----|-----|--------|
| aes_key_nr | ordinal | number | of | AES | key | in | the | reader |
| des_key_nr | ordinal | number | of | DES | key | in | the | reader |

| | |
|--|---|
| des2k_key_nr des3k_key_nr | ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| file_id | ID of file that will be created (0 – 31) |
| file_size | file size in bytes |
| read_key_no | key for reading |
| write_key_no | key for writing |
| read_write_key_no | key for reading and writing |
| change_key_no | key for changing this setting |
| communication_settings | variable that contains communication settings |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireDeleteFile (deprecated)
uFR_int_DesfireDeleteFile_PK
uFR_int_DesfireDeleteFile_no_auth
uFR_int_DesfireDeleteFile_aes (alias for uFR_int_DesfireDeleteFile)
uFR_int_DesfireDeleteFile_des
uFR_int_DesfireDeleteFile_2k3des
uFR_int_DesfireDeleteFile_3k3des
uFR_int_DesfireDeleteFile_aes_PK (alias for uFR_int_DesfireDeleteFile_PK)
uFR_int_DesfireDeleteFile_des_PK
uFR_int_DesfireDeleteFile_2k3des_PK
uFR_int_DesfireDeleteFile_3k3des_PK
uFR_SAM_DesfireDeleteFileAesAuth
uFR_SAM_DesfireDeleteFileDesAuth
uFR_SAM_DesfireDeleteFile2k3desAuth
uFR_SAM_DesfireDeleteFile3k3desAuth

Function description

Function deactivates a file within the currently selected application. Allocated memory blocks associated with deleted file not set free. Only format card function can delete the memory blocks. Is the application master key authentication is required, depending on the application master key settings.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireDeleteFile(uint8_t aes_key_nr,
                                     uint32_t aid,
                                     uint8_t file_id,
                                     uint16_t *card_status,
                                     uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteFile_PK(uint8_t *aes_key_ext,
                                         uint32_t aid,
                                         uint8_t file_id,
                                         uint16_t *card_status,
                                         uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteFile_no_auth(uint32_t aid,
                                              uint8_t file_id,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.


```

UFR_STATUS uFR_int_DesfireDeleteFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteFile_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteFile_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteFile_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDeleteFile_des_PK(
    uint8_t *des_key_ext,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);

```

```
UFR_STATUS uFR_int_DesfireDeleteFile_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireDeleteFile_3k3des_PK(
    uint8_t *des3k_key_ext,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);
```

*only uFR CS with SAM support

```
UFR_STATUS uFR_SAM_DesfireDeleteFileAesAuth(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```
UFR_STATUS uFR_SAM_DesfireDeleteFileDesAuth(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```
UFR_STATUS uFR_SAM_DesfireDeleteFile2k3desAuth(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```
UFR_STATUS uFR_SAM_DesfireDeleteFile3k3desAuth(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint16_t *card_status,
    uint16_t *exec_time);
```

Parameters

| | | | | | | | | | |
|---------------|--|--------|----|--------|-------|------------|-----|--------|-----|
| aes_key_nr | ordinal | number | of | AES | key | in | the | reader | |
| des_key_nr | ordinal | number | of | DES | key | in | the | reader | |
| des2k_key_nr | ordinal | number | of | 2K3DES | key | in | the | reader | |
| des3k_key_nr | ordinal number of 3K3DES key in the reader | | | | | | | | |
| aes_key_ext | pointer | to | 16 | bytes | array | containing | the | AES | key |
| des_key_ext | pointer | to | 8 | bytes | array | containing | the | DES | key |
| des2k_key_ext | pointer | to | 16 | bytes | array | containing | the | 2K3DES | key |

| | |
|----------------------|---|
| des3k_key_ext | pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| file_id | ID of file that will be deleted (0 – 31) |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireReadStdDataFile (deprecated)
uFR_int_DesfireReadStdDataFile_PK (deprecated)
uFR_int_DesfireReadStdDataFile_no_auth
uFR_int_DesfireReadStdDataFile_aes (alias for uFR_int_DesfireReadStdDataFile)
uFR_int_DesfireReadStdDataFile_des
uFR_int_DesfireReadStdDataFile_2k3des
uFR_int_DesfireReadStdDataFile_3k3des
uFR_int_DesfireReadStdDataFile_aes_PK (alias for uFR_int_DesfireReadStdDataFile_PK)
uFR_int_DesfireReadStdDataFile_des_PK
uFR_int_DesfireReadStdDataFile_2k3des_PK
uFR_int_DesfireReadStdDataFile_3k3des_PK
uFR_SAM_DesfireReadStdDataFileAesAuth
uFR_SAM_DesfireReadStdDataFileDesAuth
uFR_SAM_DesfireReadStdDataFile2k3desAuth
uFR_SAM_DesfireReadStdDataFile3k3desAuth

Function description

Function allows to read data from Standard Data File, or from Backup Data File. Read command requires a preceding authentication either with the key specified for Read or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireReadStdDataFile(uint8_t aes_key_nr,
                                           uint32_t aid,
                                           uint8_t aid_key_nr,
                                           uint8_t file_id,
                                           uint16_t offset,
                                           uint16_t data_length,
                                           uint8_t
communication_settings,
                                           uint8_t *data,
                                           uint16_t *card_status,
                                           uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadStdDataFile_PK(
                                           uint8_t *aes_key_ext,
                                           uint32_t aid,
                                           uint8_t aid_key_nr,
                                           uint8_t file_id,
                                           uint16_t offset,
                                           uint16_t data_length,
                                           uint8_t
communication_settings,
                                           uint8_t *data,
                                           uint16_t *card_status,
                                           uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadStdDataFile_no_auth(
                                           uint32_t aid,
                                           uint8_t aid_key_nr,
                                           uint8_t file_id,
                                           uint16_t offset,
                                           uint16_t data_length,
                                           uint8_t
communication_settings,
                                           uint8_t *data,
                                           uint16_t *card_status,
                                           uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.

```

UFR_STATUS uFR_int_DesfireReadStdDataFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadStdDataFile_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadStdDataFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadStdDataFile_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadStdDataFile_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,

```

```

uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_des_PK(
uint8_t *des_key_ext,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_2k3des_PK(
uint8_t *des2k_key_ext,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

```

*only uFR CS with SAM support

```

UFR_STATUS uFR_SAM_DesfireReadStdDataFileAesAuth(
uint8_t aes_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadStdDataFileDesAuth(

```

```

uint8_t des_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

```

```

UFR_STATUS uFR_SAM_DesfireReadStdDataFile2k3desAuth(
uint8_t des2k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

```

```

UFR_STATUS uFR_SAM_DesfireReadStdDataFile3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |

| | |
|-------------------------------|---|
| aid_key_nr | key number into application |
| file_id | ID of file (0 – 31) |
| offset | start position for read operation within file |
| data_length | number of data to be read |
| communication_settings | value must be same as in file declaration |
| data | pointer to data array |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireWriteStdDataFile (deprecated)

uFR_int_DesfireWriteStdDataFile_PK (deprecated)

uFR_int_DesfireWriteStdDataFile_no_auth

uFR_int_DesfireWriteStdDataFile_aes (alias for uFR_int_DesfireWriteStdDataFile)

uFR_int_DesfireWriteStdDataFile_des

uFR_int_DesfireWriteStdDataFile_2k3des

uFR_int_DesfireWriteStdDataFile_3k3des

uFR_int_DesfireWriteStdDataFile_aes_PK (alias for uFR_int_DesfireWriteStdDataFile_PK)

uFR_int_DesfireWriteStdDataFile_des_PK

uFR_int_DesfireWriteStdDataFile_2k3des_PK

uFR_int_DesfireWriteStdDataFile_3k3des_PK

uFR_SAM_DesfireWriteStdDataFileAesAuth

uFR_SAM_DesfireWriteStdDataFileDesAuth

uFR_SAM_DesfireWriteStdDataFile2k3desAuth

uFR_SAM_DesfireWriteStdDataFile3k3desAuth

Function description

Function allow to write data to Standard Data File, or to Backup Data File. Write command requires a preceding authentication either with the key specified for Write or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireWriteStdDataFile(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteStdDataFile_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteStdDataFile_no_auth(
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

```

For uFR PLUS devices only. DES keys support.

```

UFR_STATUS uFR_int_DesfireWriteStdDataFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteStdDataFile_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteStdDataFile_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteStdDataFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteStdDataFile_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,

```

```

uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_des_PK(
uint8_t *des_key_ext,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_2k3des_PK(
uint8_t *des2k_key_ext,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

```

*only uFR CS with SAM support

```

UFR_STATUS uFR_SAM_DesfireWriteStdDataFileAesAuth(
uint8_t aes_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireWriteStdDataFileDesAuth(

```

```

uint8_t des_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireWriteStdDataFile2k3desAuth(
uint8_t des2k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireWriteStdDataFile3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |

| | |
|-------------------------------|---|
| aid_key_nr | key number into application |
| file_id | ID of file (0 – 31) |
| offset | start position for read operation within file |
| data_length | number of data to be read |
| communication_settings | value must be same as in file declaration |
| data | pointer to data array |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

DES_to_AES_key_type

Function description

Function allow to change the card master key type from DES to AES. Factory setting for DESFIRE card master key is DES key type, and value is 0x0000000000000000. Because the reader uses AES keys, you must change the type key on AES. New AES key is 0x00000000000000000000000000000000.

Function declaration (C language)

```
UFR_STATUS DES_to_AES_key_type(void);
```

AES_to_DES_key_type

Function description

Function allow to change the card master key type from AES to DES. Set master AES key before use this function to 0x00000000000000000000000000000000. New DES key will be 0x0000000000000000 as in factory settings.

Function declaration (C language)

```
UFR_STATUS AES_to_DES_key_type(void);
```

uFR_int_DesfireCreateValueFile (deprecated)
uFR_int_DesfireCreateValueFile_PK (deprecated)
uFR_int_DesfireCreateValueFile_no_auth
uFR_int_DesfireCreateValueFile_aes (alias for uFR_int_DesfireCreateValueFile)
uFR_int_DesfireCreateValueFile_des
uFR_int_DesfireCreateValueFile_2k3des
uFR_int_DesfireCreateValueFile_3k3des
uFR_int_DesfireCreateValueFile_aes_PK (alias for uFR_int_DesfireCreateValueFile_PK)
uFR_int_DesfireCreateValueFile_des_PK
uFR_int_DesfireCreateValueFile_2k3des_PK
uFR_int_DesfireCreateValueFile_3k3des_PK
uFR_SAM_DesfireCreateValueFileAesAuth
uFR_SAM_DesfireCreateValueFileDesAuth
uFR_SAM_DesfireCreateValueFile2k3desAuth
uFR_SAM_DesfireCreateValueFile3k3desAuth

Function description

For uFR PLUS devices only.

Function allows to create file for the storage and manipulation of 32 bit signed integer values within existing application on the card. Maximal number of files into application is 32. The file will be created in the currently selected application. Is the application master key authentication is required, depending on the application master key settings.

Communication settings define communication mode between reader and card. The communication modes are:

- plain communication communication settings value is 0x00
- plain communication secured by MACing communication settings value is 0x01
- fully enciphered communication communication settings value is 0x03

Access rights for read, write, read&write and changing, references certain key within application's keys (0 – 13). If value is 14, this means free access, independent of previous authentication. If value is 15, this means deny access (for example if write access is 15 then the file type is read only).

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireCreateValueFile(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    int32_t lower_limit,
    int32_t upper_limit,
    int32_t value,
    uint8_t limited_credit_enabled,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t file_id,
    uint8_t lower_limit,
    int32_t upper_limit,
    int32_t value,
    uint8_t limited_credit_enabled,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_no_auth(
    uint32_t aid,
    uint8_t file_id,
    int32_t lower_limit,
    int32_t upper_limit,
    int32_t value,
    uint8_t limited_credit_enabled,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    int32_t lower_limit,
    int32_t upper_limit,

```

```

        int32_t value,
        uint8_t limited_credit_enabled,
        uint8_t read_key_no,
        uint8_t write_key_no,
        uint8_t read_write_key_no,
        uint8_t change_key_no,
        uint8_t communication_settings,
        uint16_t *card_status,
        uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_des(
        uint8_t des_key_nr,
        uint32_t aid,
        uint8_t file_id,
        int32_t lower_limit,
        int32_t upper_limit,
        int32_t value,
        uint8_t limited_credit_enabled,
        uint8_t read_key_no,
        uint8_t write_key_no,
        uint8_t read_write_key_no,
        uint8_t change_key_no,
        uint8_t communication_settings,
        uint16_t *card_status,
        uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_2k3des(
        uint8_t des2k_key_nr,
        uint32_t aid,
        uint8_t file_id,
        int32_t lower_limit,
        int32_t upper_limit,
        int32_t value,
        uint8_t limited_credit_enabled,
        uint8_t read_key_no,
        uint8_t write_key_no,
        uint8_t read_write_key_no,
        uint8_t change_key_no,
        uint8_t communication_settings,
        uint16_t *card_status,
        uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_3k3des(
        uint8_t des3k_key_nr,
        uint32_t aid,
        uint8_t file_id,
        int32_t lower_limit,
        int32_t upper_limit,
        int32_t value,
        uint8_t limited_credit_enabled,
        uint8_t read_key_no,
        uint8_t write_key_no,
        uint8_t read_write_key_no,
        uint8_t change_key_no,

```



```

uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_aes_PK(
uint8_t *aes_key_ext,
uint32_t aid,
uint8_t file_id,
int32_t lower_limit,
int32_t upper_limit,
int32_t value,
uint8_t limited_credit_enabled,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_des_PK(
uint8_t *des_key_ext,
uint32_t aid,
uint8_t file_id,
int32_t lower_limit,
int32_t upper_limit,
int32_t value,
uint8_t limited_credit_enabled,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_2k3des_PK(
uint8_t *des2k_key_ext,
uint32_t aid,
uint8_t file_id,
int32_t lower_limit,
int32_t upper_limit,
int32_t value,
uint8_t limited_credit_enabled,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateValueFile_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,

```

```

uint8_t file_id,
int32_t lower_limit,
int32_t upper_limit,
int32_t value,
uint8_t limited_credit_enabled,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

```

*only uFR CS with SAM support

```

UFR_STATUS uFR_SAM_DesfireCreateValueFileAesAuth(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    int32_t lower_limit,
    int32_t upper_limit,
    int32_t value,
    uint8_t limited_credit_enabled,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

```

```

UFR_STATUS uFR_SAM_DesfireCreateValueFileDesAuth(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t file_id,
    int32_t lower_limit,
    int32_t upper_limit,
    int32_t value,
    uint8_t limited_credit_enabled,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

```

```

UFR_STATUS uFR_SAM_DesfireCreateValueFile2k3desAuth(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    int32_t lower_limit,
    int32_t upper_limit,
    int32_t value,

```

```

uint8_t limited_credit_enabled,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateValueFile3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint8_t file_id,
int32_t lower_limit,
int32_t upper_limit,
int32_t value,
uint8_t limited_credit_enabled,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| file_id | ID of file that will be created (0 – 31) |
| lower_limit | lower limit which is valid for this file |
| upper_limit | upper limit which is valid for this file |
| value | initial value of the value file |

| | |
|-------------------------------|--|
| limited_credit_enabled | bit 0 – limited credit enabled (1 – yes, 0 – no) bit 1 – free get value (1 – yes, 0 – no) |
| read_key_no | key for get and debit value |
| write_key_no | key for get, debit and limited credit value |
| read_write_key_no | for get, debit, limited credit and credit value |
| change_key_no | key for changing this setting |
| communication_settings | variable that contains communication settings |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireReadValueFile (deprecated)

uFR_int_DesfireReadValueFile_PK (deprecated)

uFR_int_DesfireReadValueFile_no_auth

uFR_int_DesfireReadValueFile_aes (alias for uFR_int_DesfireReadValueFile)

uFR_int_DesfireReadValueFile_des

uFR_int_DesfireReadValueFile_2k3des

uFR_int_DesfireReadValueFile_3k3des

uFR_int_DesfireReadValueFile_aes_PK (alias for uFR_int_DesfireReadValueFile_PK)

uFR_int_DesfireReadValueFile_des_PK

uFR_int_DesfireReadValueFile_2k3des_PK

uFR_int_DesfireReadValueFile_3k3des_PK

uFR_SAM_DesfireReadValueFileAesAuth

uFR_SAM_DesfireReadValueFileDesAuth

uFR_SAM_DesfireReadValueFile2k3desAuth

uFR_SAM_DesfireReadValueFile3k3desAuth

Function description

For uFR PLUS devices only.

Function allow to read value from value files. Read command requires a preceding authentication either with the key specified for Read or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireReadValueFile(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadValueFile_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadValueFile_no_auth(
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadValueFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadValueFile_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadValueFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

```

```

UFR_STATUS uFR_int_DesfireReadValueFile_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadValueFile_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadValueFile_des_PK(
    uint8_t *des_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadValueFile_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadValueFile_3k3des_PK(
    uint8_t *des3k_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

*only uFR CS with SAM support

UFR_STATUS uFR_SAM_DesfireReadValueFileAesAuth(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,

```

```

uint8_t file_id,
uint8_t communication_settings,
int32_t *value,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadValueFileDesAuth(
uint8_t des_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint8_t communication_settings,
int32_t *value,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadValueFile2k3desAuth(
uint8_t des2k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint8_t communication_settings,
int32_t *value,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadValueFile3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint8_t communication_settings,
int32_t *value,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| aid_key_nr | key number into application |

| | |
|-------------------------------|---|
| | |
| communication_settings | value must be the same as in file declaration |
| value | pointer to value variable |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireIncreaseValueFile (deprecated)
uFR_int_DesfireIncreaseValueFile_PK (deprecated)
uFR_int_DesfireIncreaseValueFile_no_auth
uFR_int_DesfireIncreaseValueFile_aes (alias for uFR_int_DesfireIncreaseValueFile)
uFR_int_DesfireIncreaseValueFile_des
uFR_int_DesfireIncreaseValueFile_2k3des
uFR_int_DesfireIncreaseValueFile_3k3des
uFR_int_DesfireIncreaseValueFile_aes_PK (alias for uFR_int_DesfireIncreaseValueFile_PK)
uFR_int_DesfireIncreaseValueFile_des_PK
uFR_int_DesfireIncreaseValueFile_2k3des_PK
uFR_int_DesfireIncreaseValueFile_3k3des_PK
uFR_SAM_DesfireIncreaseValueFileAesAuth
uFR_SAM_DesfireIncreaseValueFileDesAuth
uFR_SAM_DesfireIncreaseValueFile2k3desAuth
uFR_SAM_DesfireIncreaseValueFile3k3desAuth

Function description

For uFR PLUS devices only.

Function allows to increase a value stored in a value files. Credit command requires a preceding authentication with the key specified for Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

NOTE: Transaction MAC file exist by factory default setting. For using this function, user must delete transaction MAC file first.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireIncreaseValueFile(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t communication_settings,
    int32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireIncreaseValueFile_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t communication_settings,
    int32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

FR_STATUS uFR_int_DesfireIncreaseValueFile_no_auth(
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t communication_settings,
    int32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireIncreaseValueFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireIncreaseValueFile_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireIncreaseValueFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

```

```

UFR_STATUS uFR_int_DesfireIncreaseValueFile_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireIncreaseValueFile_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireIncreaseValueFile_des_PK(
    uint8_t *des_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireIncreaseValueFile_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireIncreaseValueFile_3k3des_PK(
    uint8_t *des3k_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

*only uFR CS with SAM support

UFR_STATUS uFR_SAM_DesfireIncreaseValueFileAesAuth(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,

```

```

uint8_t file_id,
uint8_t communication_settings,
uint32_t value,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFileDesAuth(
uint8_t des_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint8_t communication_settings,
uint32_t value,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFile2k3desAuth(
uint8_t des2k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint8_t communication_settings,
uint32_t value,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFile3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint8_t communication_settings,
uint32_t value,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| aid_key_nr | key number into application |

| | |
|-------------------------------|---|
| | |
| communication_settings | value must be the same as in file declaration |
| value | value (must be a positive number) |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireDecreaseValueFile (deprecated)
uFR_int_DesfireDecreaseValueFile_PK (deprecated)
uFR_int_DesfireDecreaseValueFile_no_auth
uFR_int_DesfireDecreaseValueFile_aes (alias for uFR_int_DesfireDecreaseValueFile)
uFR_int_DesfireDecreaseValueFile_des
uFR_int_DesfireDecreaseValueFile_2k3des
uFR_int_DesfireDecreaseValueFile_3k3des
uFR_int_DesfireDecreaseValueFile_aes_PK (alias for uFR_int_DesfireDecreaseValueFile_PK)
uFR_int_DesfireDecreaseValueFile_des_PK
uFR_int_DesfireDecreaseValueFile_2k3des_PK
uFR_int_DesfireDecreaseValueFile_3k3des_PK
uFR_SAM_DesfireDecreaseValueFileAesAuth
uFR_SAM_DesfireDecreaseValueFileDesAuth
uFR_SAM_DesfireDecreaseValueFile2k3desAuth
uFR_SAM_DesfireDecreaseValueFile3k3desAuth

Function description

For uFR PLUS devices only

Function allows to decrease value from value files. Debit command requires a preceding authentication with one of the keys specified for Read, Write or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

NOTE: Transaction MAC file exist by factory default setting. For using this function, user must delete transaction MAC file first.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireDecreaseValueFile(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t communication_settings,
    int32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDecreaseValueFile_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t communication_settings,
    int32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDecreaseValueFile_no_auth(
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t communication_settings,
    int32_t *value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDecreaseValueFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDecreaseValueFile_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDecreaseValueFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

```

```

UFR_STATUS uFR_int_DesfireDecreaseValueFile_3k3des(
    uint8_t des3_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDecreaseValueFile_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDecreaseValueFile_des_PK(
    uint8_t *des_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDecreaseValueFile_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireDecreaseValueFile_3k3des_PK(
    uint8_t *des3k_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint8_t communication_settings,
    uint32_t value,
    uint16_t *card_status,
    uint16_t *exec_time);

*only uFR CS with SAM support

UFR_STATUS uFR_SAM_DesfireDecreaseValueFileAesAuth(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,

```

```

uint8_t file_id,
uint8_t communication_settings,
uint32_t value,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFileDesAuth(
uint8_t des_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint8_t communication_settings,
uint32_t value,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFile2k3desAuth(
uint8_t des2k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint8_t communication_settings,
uint32_t value,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFile3k3desAuth(
uint8_t des3_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint8_t communication_settings,
uint32_t value,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| aid_key_nr | key number into application |

| | |
|-------------------------------|---|
| | |
| communication_settings | value must be the same as in file declaration |
| value | value (must be a positive number) |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

uFR_int_DesfireGetApplicationIds (deprecated)
uFR_int_DesfireGetApplicationIds_PK (deprecated)
uFR_int_DesfireGetApplicationIds_no_auth
uFR_int_DesfireGetApplicationIds_aes (alias for uFR_int_DesfireGetApplicationIds)
uFR_int_DesfireGetApplicationIds_des
uFR_int_DesfireGetApplicationIds_2k3des
uFR_int_DesfireGetApplicationIds_3k3des
uFR_int_DesfireGetApplicationIds_aes_PK (alias for
uFR_int_DesfireGetApplicationIds_PK)
uFR_int_DesfireGetApplicationIds_des_PK
uFR_int_DesfireGetApplicationIds_2k3des_PK
uFR_int_DesfireGetApplicationIds_3k3des_PK
uFR_SAM_DesfireGetApplicationIdsAesAuth
uFR_SAM_DesfireGetApplicationIdsDesAuth
uFR_SAM_DesfireGetApplicationIds2k3desAuth
uFR_SAM_DesfireGetApplicationIds3k3desAuth

Function description

For uFR PLUS devices only

Function returns the Application Identifiers for all active applications on a card.

Function declaration (C language)

```

UFR_STATUS DL_API uFR_int_DesfireGetApplicationIds(
    uint8_t aes_key_nr,
    uint32_t *application_ids,
    uint8_t *number_of_aplication_ids,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS DL_API uFR_int_DesfireGetApplicationIds_PK(
    uint8_t *aes_key_ext,
    uint32_t *application_ids,
    uint8_t *number_of_aplication_ids,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetApplicationIds_no_auth(
    uint32_t *application_ids,
    uint8_t *number_of_aplication_ids,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetApplicationIds_aes(
    uint8_t aes_key_nr,
    uint32_t *application_ids,
    uint8_t *number_of_aplication_ids,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetApplicationIds_des(
    uint8_t des_key_nr,
    uint32_t *application_ids,
    uint8_t *number_of_aplication_ids,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetApplicationIds_2k3des(
    uint8_t des2k_key_nr,
    uint32_t *application_ids,
    uint8_t *number_of_aplication_ids,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetApplicationIds_3k3des(
    uint8_t des3k_key_nr,
    uint32_t *application_ids,
    uint8_t *number_of_aplication_ids,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetApplicationIds_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t *application_ids,
    uint8_t *number_of_aplication_ids,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireGetApplicationIds_des_PK(
    uint8_t *des_key_ext,
    uint32_t *application_ids,

```

```

        uint8_t *number_of_aplication_ids,
        uint16_t *card_status,
        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_2k3des_PK(
        uint8_t *des2k_key_ext,
        uint32_t *application_ids,
        uint8_t *number_of_aplication_ids,
        uint16_t *card_status,
        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_3k3des_PK(
        uint8_t *des3k_key_ext,
        uint32_t *application_ids,
        uint8_t *number_of_aplication_ids,
        uint16_t *card_status,
        uint16_t *exec_time);

*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireGetApplicationIdsAesAuth(
        uint8_t aes_key_nr,
        uint32_t *application_ids,
        uint8_t *number_of_aplication_ids,
        uint16_t *card_status,
        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireGetApplicationIdsDesAuth(
        uint8_t des_key_nr,
        uint32_t *application_ids,
        uint8_t *number_of_aplication_ids,
        uint16_t *card_status,
        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireGetApplicationIds2k3desAuth(
        uint8_t des2k_key_nr,
        uint32_t *application_ids,
        uint8_t *number_of_aplication_ids,
        uint16_t *card_status,
        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireGetApplicationIds3k3desAuth(
        uint8_t des3k_key_nr,
        uint32_t *application_ids,
        uint8_t *number_of_aplication_ids,
        uint16_t *card_status,
        uint16_t *exec_time);

```

Parameters

| | |
|--------------|--|
| aes_key_nr | ordinal number of AES key in the reader |
| des_key_nr | ordinal number of DES key in the reader |
| des2k_key_nr | ordinal number of 2K3DES key in the reader |
| des3k_key_nr | ordinal number of 3K3DES key in the reader |

| | |
|--|---|
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aplication_ids | array of application identifiers |
| number_of_application_ids | number of application identifiers |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

[*uFR_int_DesfireCreateLinearRecordFile_aes*](#)
[*uFR_int_DesfireCreateLinearRecordFile_des*](#)
[*uFR_int_DesfireCreateLinearRecordFile_2k3des*](#)
[*uFR_int_DesfireCreateLinearRecordFile_3k3des*](#)
[*uFR_int_DesfireCreateLinearRecordFile_aes_PK*](#)
[*uFR_int_DesfireCreateLinearRecordFile_des_PK*](#)
[*uFR_int_DesfireCreateLinearRecordFile_2k3des_PK*](#)
[*uFR_int_DesfireCreateLinearRecordFile_3k3des_PK*](#)
[*uFR_int_DesfireCreateLinearRecordFile_no_auth*](#)
[*uFR_SAM_DesfireCreateLinearRecordFileAesAuth*](#)
[*uFR_SAM_DesfireCreateLinearRecordFileDesAuth*](#)
[*uFR_SAM_DesfireCreateLinearRecordFile2k3desAuth*](#)
[*uFR_SAM_DesfireCreateLinearRecordFile3k3desAuth*](#)

For uFR PLUS devices only.

Function description

Function allows to create file for multiple storage of structural data, within an existing application. Once the file filled completely with data records, further writing to file is not possible unless it is cleared.

Maximal number of files into application is 32. The file will be created in the currently selected application. Is the application master key authentication is required, depend on the application master key settings.

Communication settings define communication mode between reader and card. The communication modes are:

- plain communication communication settings value is 0x00
- plain communication secured by MACing communication settings value is 0x01
- fully enciphered communication communication settings value is 0x03

Access rights for read, write, read&write and changing, references certain key within application's

keys (0 – 13). If value is 14, this means free access, independent of previous authentication. If value is 15, this means deny access (for example if write access is 15 then the file type is read only).

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid, uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_des(
    uint8_t des_key_nr,
    uint32_t aid, uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```

UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid, uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid, uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_des_PK(
    uint8_t *des_key_ext,
    uint32_t aid,
    uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_2k3des_PK(

```

```

uint8_t *des2k_key_ext,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_no_auth(
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireCreateLinearRecordFileAesAuth(
uint8_t aes_key_nr,
uint32_t aid, uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

```

```

UFR_STATUS uFR_SAM_DesfireCreateLinearRecordFileDesAuth(
    uint8_t des_key_nr,
    uint32_t aid, uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreateLinearRecordFile2k3desAuth(
    uint8_t des2k_key_nr,
    uint32_t aid, uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireCreateLinearRecordFile3k3desAuth(
    uint8_t des3k_key_nr,
    uint32_t aid, uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |

| | |
|-------------------------------|---|
| aid | ID of application that contains the file |
| file_id | ID of file that will be created (0 – 31) |
| record_size | size of record in bytes |
| max_rec_no | maximal number of records in file |
| read_key_no | key for reading |
| write_key_no | key for writing |
| read_write_key_no | key for reading and writing |
| change_key_no | key for changing this setting |
| communication_settings | variable that contains communication settings |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

[*uFR_int_DesfireCreateCyclicRecordFile_aes*](#)
[*uFR_int_DesfireCreateCyclicRecordFile_des*](#)
[*uFR_int_DesfireCreateCyclicRecordFile_2k3des*](#)
[*uFR_int_DesfireCreateCyclicRecordFile_3k3des*](#)
[*uFR_int_DesfireCreateCyclicRecordFile_aes_PK*](#)
[*uFR_int_DesfireCreateCyclicRecordFile_des_PK*](#)
[*uFR_int_DesfireCreateCyclicRecordFile_2k3des_PK*](#)
[*uFR_int_DesfireCreateCyclicRecordFile_3k3des_PK*](#)
[*uFR_int_DesfireCreateCyclicRecordFile_no_auth*](#)
[*uFR_SAM_DesfireCreateCyclicRecordFileAesAuth*](#)
[*uFR_SAM_DesfireCreateCyclicRecordFileDesAuth*](#)
[*uFR_SAM_DesfireCreateCyclicRecordFile2k3desAuth*](#)
[*uFR_SAM_DesfireCreateCyclicRecordFile3k3desAuth*](#)

For uFR PLUS devices only.

Function description

Function allows to create file for multiple storage of structural data, within an existing application. Once the file filled completely with data records, the card automatically overwrites the oldest record with latest written one.

Maximal number of files into application is 32. The file will be created in the currently selected application. Is the application master key authentication is required, depend on the application master key settings.

Communication settings define communication mode between reader and card. The communication modes are:

- plain communication communication settings value is 0x00
- plain communication secured by MACing communication settings value is 0x01
- fully enciphered communication communication settings value is 0x03

Access rights for read, write, read&write and changing, references certain key within application's keys (0 – 13). If value is 14, this means free access, independent of previous authentication. If value is 15, this means deny access (for example if write access is 15 then the file type is read only).

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    uint32_t record_size,
    uint32_t max_rec_no,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t communication_settings,
    uint8_t *card_status,
    uint8_t *exec_time);

```

```

uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_aes_PK(
uint8_t *aes_key_ext,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_des_PK(
uint8_t *des_key_ext,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_2k3des_PK(
uint8_t *des2k_key_ext,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,

```

```

uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_no_auth(
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

```

*only uFR CS with SAM support

```

UFR_STATUS uFR_SAM_DesfireCreateCyclicRecordFileAesAuth(
uint8_t aes_key_nr,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateCyclicRecordFileDesAuth(
uint8_t des_key_nr,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateCyclicRecordFile2k3desAuth(
uint8_t des2k_key_nr,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,

```

```

uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateCyclicRecordFile3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint8_t file_id,
uint32_t record_size,
uint32_t max_rec_no,
uint8_t read_key_no,
uint8_t write_key_no,
uint8_t read_write_key_no,
uint8_t change_key_no,
uint8_t communication_settings,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| file_id | ID of file that will be created (0 – 31) |
| record_size | size of record in bytes |
| max_rec_no | maximal number of records in file |
| read_key_no | key for reading |
| write_key_no | key for writing |
| read_write_key_no | key for reading and writing |

| | |
|-------------------------------|---|
| change_key_no | key for changing this setting |
| communication_settings | variable that contains communication settings |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

[*uFR_int_DesfireWriteRecord_aes*](#)
[*uFR_int_DesfireWriteRecord_des*](#)
[*uFR_int_DesfireWriteRecord_2k3des*](#)
[*uFR_int_DesfireWriteRecord_3k3des*](#)
[*uFR_int_DesfireWriteRecord_aes_PK*](#)
[*uFR_int_DesfireWriteRecord_des_PK*](#)
[*uFR_int_DesfireWriteRecord_2k3des_PK*](#)
[*uFR_int_DesfireWriteRecord_3k3des_PK*](#)
[*uFR_int_DesfireWriteRecord_no_auth*](#)
[*uFR_SAM_DesfireWriteRecordAesAuth*](#)
[*uFR_SAM_DesfireWriteRecordDesAuth*](#)
[*uFR_SAM_DesfireWriteRecord2k3desAuth*](#)
[*uFR_SAM_DesfireWriteRecord3k3desAuth*](#)

For uFR PLUS devices only.

Function description

Function allows to write data to a record in a Linear Record File or Cyclic Record File. Write command requires a preceding authentication either with the key specified for Write or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

NOTE: Transaction MAC file exist by factory default setting. For using this function, user must delete transaction MAC file first.

Function declaration (C language)

```

UFR_STATUS uFR_int_DesfireWriteRecord_aes(uint8_t aes_key_nr,
                                           uint32_t aid,
                                           uint8_t aid_key_nr,
                                           uint8_t file_id,
                                           uint16_t offset,
                                           uint16_t data_length,
                                           uint8_t communication_settings,
                                           uint8_t *data,
                                           uint16_t *card_status,
                                           uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteRecord_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteRecord_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteRecord_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteRecord_aes_PK(
    IN uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t data_length,

```

```

        uint8_t communication_settings,
        uint8_t *data,
        uint16_t *card_status,
        uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteRecord_des_PK(
        uint8_t *des_key_ext,
        uint32_t aid,
        uint8_t aid_key_nr,
        uint8_t file_id,
        uint16_t offset,
        uint16_t data_length,
        uint8_t communication_settings,
        uint8_t *data,
        uint16_t *card_status,
        uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteRecord_2k3des_PK(
        uint8_t *des2k_key_ext,
        uint32_t aid,
        uint8_t aid_key_nr,
        uint8_t file_id,
        uint16_t offset,
        uint16_t data_length,
        uint8_t communication_settings,
        uint8_t *data,
        uint16_t *card_status,
        uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteRecord_3k3des_PK(
        uint8_t *des3k_key_ext,
        uint32_t aid,
        uint8_t aid_key_nr,
        uint8_t file_id,
        uint16_t offset,
        uint16_t data_length,
        uint8_t communication_settings,
        uint8_t *data,
        uint16_t *card_status,
        uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireWriteRecord_no_auth(
        uint32_t aid,
        uint8_t aid_key_nr,
        uint8_t file_id,
        uint16_t offset,
        uint16_t data_length,
        uint8_t communication_settings,
        uint8_t *data,
        uint16_t *card_status,
        uint16_t *exec_time);

```

*only uFR CS with SAM support

```

UFR_STATUS uFR_SAM_DesfireWriteRecordAesAuth(uint8_t aes_key_nr,
        uint32_t aid,

```



```

uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireWriteRecordDesAuth(
uint8_t des_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireWriteRecord2k3desAuth(
uint8_t des2k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

UFR_STATUS uFR_SAM_DesfireWriteRecord3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t data_length,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--------------|--|
| aes_key_nr | ordinal number of AES key in the reader |
| des_key_nr | ordinal number of DES key in the reader |
| des2k_key_nr | ordinal number of 2K3DES key in the reader |
| des3k_key_nr | ordinal number of 3K3DES key in the reader |

| | |
|--|---|
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| aid_key_nr | key number into application |
| file_id | ID of file (0 – 31) |
| offset | start position for read operation within file |
| data_length | number of data to be read |
| communication_settings | value must be the same as in file declaration |
| data | pointer to data array |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

[*uFR_int_DesfireReadRecords_aes*](#)
[*uFR_int_DesfireReadRecords_des*](#)
[*uFR_int_DesfireReadRecords_2k3des*](#)
[*uFR_int_DesfireReadRecords_3k3des*](#)
[*uFR_int_DesfireReadRecords_aes_PK*](#)
[*uFR_int_DesfireReadRecords_des_PK*](#)
[*uFR_int_DesfireReadRecords_2k3des_PK*](#)
[*uFR_int_DesfireReadRecords_3k3des_PK*](#)
[*uFR_int_DesfireReadRecords_no_auth*](#)
[*uFR_SAM_DesfireReadRecordsAesAuth*](#)
[*uFR_SAM_DesfireReadRecordsDesAuth*](#)
[*uFR_SAM_DesfireReadRecords2k3desAuth*](#)
[*uFR_SAM_DesfireReadRecords3k3desAuth*](#)

For uFR PLUS devices only.

Function description

Function allows to read data from a record in a Linear Record File or Cyclic Record File. Read command requires a preceding authentication either with the key specified for Read or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireReadRecords_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t number_of_records,
    uint16_t record_size,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadRecords_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t number_of_records,
    uint16_t record_size,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);
```

```

UFR_STATUS uFR_int_DesfireReadRecords_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t number_of_records,
    uint16_t record_size,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadRecords_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t number_of_records,
    uint16_t record_size,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadRecords_aes_PK(
    uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t number_of_records,
    uint16_t record_size,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadRecords_des_PK(
    uint8_t *des_key_ext,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    uint16_t offset,
    uint16_t number_of_records,
    uint16_t record_size,
    uint8_t communication_settings,
    uint8_t *data,
    uint16_t *card_status,
    uint16_t *exec_time);

UFR_STATUS uFR_int_DesfireReadRecords_2k3des_PK(
    uint8_t *des2k_key_ext,
    uint32_t aid,

```

```

uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t number_of_records,
uint16_t record_size,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadRecords_3k3des_PK(
uint8_t *des3k_key_ext,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t number_of_records,
uint16_t record_size,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadRecords_no_auth(
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t number_of_records,
uint16_t record_size,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
VAR uint16_t *exec_time);

*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireReadRecordsAesAuth(
uint8_t aes_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t number_of_records,
uint16_t record_size,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadRecordsDesAuth(
uint8_t des_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,

```

```

uint16_t offset,
uint16_t number_of_records,
uint16_t record_size,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadRecords2k3desAuth(
uint8_t des2k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t number_of_records,
uint16_t record_size,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadRecords3k3desAuth(
uint8_t des3k_key_nr,
uint32_t aid,
uint8_t aid_key_nr,
uint8_t file_id,
uint16_t offset,
uint16_t number_of_records,
uint16_t record_size,
uint8_t communication_settings,
uint8_t *data,
uint16_t *card_status,
uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| aid_key_nr | key number into application |

| | |
|-------------------------------|---|
| file_id | ID of file (0 – 31) |
| offset | start position for read operation within file |
| number_of_records | number of records to be read |
| record_size | size of record in bytes |
| communication_settings | value must be the same as in file declaration |
| data | pointer to data array |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

`uFR_int_DesfireClearRecordFile_aes`
`uFR_int_DesfireClearRecordFile_des`
`uFR_int_DesfireClearRecordFile_2k3des`
`uFR_int_DesfireClearRecordFile_3k3des`
`uFR_int_DesfireClearRecordFile_aes_PK`
`uFR_int_DesfireClearRecordFile_des_PK`
`uFR_int_DesfireClearRecordFile_2k3des_PK`
`uFR_int_DesfireClearRecordFile_3k3des_PK`
`uFR_int_DesfireClearRecordFile_no_auth`
`uFR_SAM_DesfireClearRecordFileAesAuth`
`uFR_SAM_DesfireClearRecordFileDesAuth`
`uFR_SAM_DesfireClearRecordFile2k3desAuth`
`uFR_SAM_DesfireClearRecordFile3k3desAuth`
`uFR_int_DesfireClearRecordFile_aes_2`
`uFR_int_DesfireClearRecordFile_des_2`
`uFR_int_DesfireClearRecordFile_2k3des_2`
`uFR_int_DesfireClearRecordFile_3k3des_2`
`uFR_int_DesfireClearRecordFile_aes_PK_2`
`uFR_int_DesfireClearRecordFile_des_PK_2`
`uFR_int_DesfireClearRecordFile_2k3des_PK_2`
`uFR_int_DesfireClearRecordFile_3k3des_PK_2`
`uFR_SAM_DesfireClearRecordFileAesAuth_2`
`uFR_SAM_DesfireClearRecordFileDesAuth_2`
`uFR_SAM_DesfireClearRecordFile2k3desAuth_2`
`uFR_SAM_DesfireClearRecordFile3k3desAuth_2`

For uFR PLUS devices only.

Function description

Function allows to reset a Linear Record File or Cyclic Record file to the empty state. Clear command requires a preceding authentication with the key specified for Read&Write access.

Bug fix from library version 5.0.29. The aid key number was omitted in function parameters, so it was used application master key number 0 for Read&Write access. For compatibility reasons old functions were retained. New function names have the “_2” suffix.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

NOTE: Transaction MAC file exist by factory default setting. For using this function, user must delete transaction MAC file first.

Function declaration (C language)

```

UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_aes(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);

UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_des(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);

UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_2k3des(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);

UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_3k3des(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);

UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_aes_PK(
    IN uint8_t *aes_key_ext,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);

UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_des_PK(
    IN uint8_t *des_key_ext,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);

UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_2k3des_PK(
    IN uint8_t *des2k_key_ext,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);

```

```
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_3k3des_PK(
    IN uint8_t *des3k_key_ext,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);
```

```
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_no_auth(
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);
```

*only uFR CS with SAM support

```
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFileAesAuth(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);
```

```
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFileDesAuth(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);
```

```
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFile2k3desAuth(
    uint8_t des2k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);
```

```
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFile3k3desAuth(
    uint8_t des3k_key_nr,
    uint32_t aid,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);
```

*From library version 5.0.29.

```
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_aes_2(
    uint8_t aes_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    VAR uint16_t *card_status,
    VAR uint16_t *exec_time);
```

```
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_des_2(
    uint8_t des_key_nr,
    uint32_t aid,
    uint8_t aid_key_nr,
    uint8_t file_id,
    VAR uint16_t *card_status,
```

```

                                VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_2k3des_2(
                                uint8_t des2k_key_nr,
                                uint32_t aid,
                                uint8_t aid_key_nr,
                                uint8_t file_id,
                                VAR uint16_t *card_status,
                                VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_3k3des_2(
                                uint8_t des3k_key_nr,
                                uint32_t aid,
                                uint8_t aid_key_nr,
                                uint8_t file_id,
                                VAR uint16_t *card_status,
                                VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFileAesAuth_2(
                                uint8_t aes_key_nr,
                                uint32_t aid,
                                uint8_t aid_key_nr,
                                uint8_t file_id,
                                VAR uint16_t *card_status,
                                VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFile3k3desAuth_2(
                                uint8_t des3k_key_nr,
                                uint32_t aid,
                                uint8_t aid_key_nr,
                                uint8_t file_id,
                                VAR uint16_t *card_status,
                                VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFileDesAuth_2(
                                uint8_t des_key_nr,
                                uint32_t aid,
                                uint8_t aid_key_nr,
                                uint8_t file_id,
                                VAR uint16_t *card_status,
                                VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFile2k3desAuth_2(
                                uint8_t des2k_key_nr,
                                uint32_t aid,
                                uint8_t aid_key_nr,
                                uint8_t file_id,
                                VAR uint16_t *card_status,
                                VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_aes_PK_2(
                                IN uint8_t *aes_key_ext,
                                uint32_t aid,
                                uint8_t aid_key_nr,
                                uint8_t file_id,
                                VAR uint16_t *card_status,
                                VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_des_PK_2(

```

```

        IN uint8_t *des_key_ext,
        uint32_t aid,
        uint8_t aid_key_nr,
        uint8_t file_id,
        VAR uint16_t *card_status,
        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_2k3des_PK_2(
        IN uint8_t *des2k_key_ext,
        uint32_t aid,
        uint8_t aid_key_nr,
        uint8_t file_id,
        VAR uint16_t *card_status,
        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_3k3des_PK_2(
        IN uint8_t *des3k_key_ext,
        uint32_t aid,
        uint8_t aid_key_nr,
        uint8_t file_id,
        VAR uint16_t *card_status,
        VAR uint16_t *exec_time);

```

Parameters

| | |
|--|---|
| aes_key_nr des_key_nr des2k_key_nr des3k_key_nr | ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader |
| aes_key_ext des_key_ext des2k_key_ext des3k_key_ext | pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key |
| aid | ID of application that contains the file |
| aid_key_nr | key number into application |
| file_id | ID of file (0 – 31) |
| card_status | pointer to card error variable |
| exec_time | function's execution time |

dfi_get_file_settings

From library version 5.0.29 and firmware version 5.0.32. Desfire Light specific command.

Function description

Function returns file settings.

Function declaration (C language)

```
UFR_STATUS DL_API dfl_get_file_settings(uint8_t file_no,  
                                         VAR uint8_t *file_type,  
                                         VAR uint8_t *communication_mode,  
                                         VAR uint8_t *read_key_no,  
                                         VAR uint8_t *write_key_no,  
                                         VAR uint8_t *read_write_key_no,  
                                         VAR uint8_t *change_key_no,  
                                         VAR uint32_t *file_size,  
                                         VAR int32_t *lower_limit,  
                                         VAR int32_t *upper_limit,  
                                         VAR uint32_t *limited_credit_value,  
                                         VAR uint8_t *limited_credit_enable,  
                                         VAR uint8_t *free_get_value,  
                                         VAR uint32_t *record_size,  
                                         VAR uint32_t *max_number_of_rec,  
                                         VAR uint32_t *curr_number_of_rec,  
                                         VAR uint8_t *ex_unauth_operation,  
                                         VAR uint8_t *tmc_limit_conf,  
                                         VAR uint8_t *tm_key_type,  
                                         VAR uint8_t *tm_key_version,  
                                         VAR uint32_t *tmc_limit);
```

Parameters

| | |
|-------------------------------|---|
| file_no | file number 0, 1, 3, 4, 15 or 31 |
| *file_type | file type 0 - standard data file, 2 - value file, 4 - cyclic record file, 5 - transaction MAC file |
| *communication_mode | communication mode 0 - plain, 1 - macked, 3 - enciphered |
| *read_key_no | read key number (0 - 4) |
| *write_key_no | write key number (0 - 4) |
| *read_write_key_no | read write key number (0 - 4) |
| *change_key_no | change key number (0 - 4) |
| *file_size | standard data file size |
| *lower_limit | value file lower limit |
| *upper_limit | value file upper limit |
| *limited_credit_value | value file limited credit value |
| *limited_credit_enable | value file limited credit enable (0 - disabled, 1 - enabled) |
| *free_get_value | value file get value without authentication (0 - disabled, 1 - enabled) |
| *record_size | cyclic record file size of record |
| *max_number_of_rec | cyclic record file maximal number of record |
| *curr_number_of_rec | cyclic record file number of used record |
| *ex_unauth_operation | TMC file exclude unauthorised operation |
| *tmc_limit_conf | TMC file limit configuration |
| *tm_key_type | TMC file key type AES |
| *tm_key_version | TMC key version |
| *tmc_limit | TMC file counter limit |

[dfl_change_file_settings](#)
[dfl_change_file_settings_pk](#)

From library version 5.0.29 and firmware version 5.0.32. Desfire Light specific command.

Function description

Function changes file settings.

Function declaration (C language)

```
UFR_STATUS dfl_change_file_settings_pk(IN uint8_t *aes_key_ext,
                                       uint8_t file_no,
                                       uint8_t key_no,
                                       uint8_t curr_communication_mode,
                                       uint8_t new_communication_mode,
                                       uint8_t read_key_no,
                                       uint8_t write_key_no,
                                       uint8_t read_write_key_no,
                                       uint8_t change_key_no);

UFR_STATUS dfl_change_file_settings(uint8_t aes_key_no,
                                    uint8_t file_no,
                                    uint8_t key_no,
                                    uint8_t curr_communication_mode,
                                    uint8_t new_communication_mode,
                                    uint8_t read_key_no,
                                    uint8_t write_key_no,
                                    uint8_t read_write_key_no,
                                    uint8_t change_key_no);
```

Parameters

| | |
|--------------------------------|--|
| *aes_key_ext | pointer to array contained AES key |
| aes_key_no | reader key number of AES key (0 -15) |
| file_no | file number 0, 1, 3, 4, 15 or 31 |
| curr_communication_mode | current communication mode 0 - plain, 1 - macked, 3 - enciphered |
| new_communication_mode | new communication mode 0 - plain, 1 - macked, 3 - enciphered |
| read_key_no | read key number (0 - 4) |
| write_key_no | write key number (0 - 4) |
| read_write_key_no | read write key number (0 - 4) |
| change_key_no | change key number (0 - 4) |

[*dfl_delete_tmc_file*](#)

[*dfl_delete_tmc_file_pk*](#)

From library version 5.0.29 and firmware version 5.0.32. Desfire Light specific command.

Function description

Function delete transaction MAC file.

NOTE: Transaction MAC file exist by factory default. To use the operations with value file, and cyclic record file, this file must be deleted.

Function declaration (C language)

```
UFR_STATUS dfl_delete_tmc_file_pk(IN uint8_t *aes_key_ext,
                                uint8_t file_no);
UFR_STATUS dfl_delete_tmc_file(uint8_t aes_key_no,
                                uint8_t file_no);
```

Parameters

| | |
|---------------------|--------------------------------------|
| *aes_key_ext | pointer to array contained AES key |
| aes_key_no | reader key number of AES key (0 -15) |
| file_no | file number 15 |

Functions for Mifare Plus card (AES encryption in reader)

For uFR PLUS devices only.

AES encryption and decryption is performed in the reader. AES keys are stored into reader.

Specific functions for Mifare Plus card

| | |
|------------|----------------------------|
| UFR_STATUS | MFP_WritePerso |
| UFR_STATUS | MFP_CommitPerso |
| UFR_STATUS | MFP_PersonalizationMinimal |
| UFR_STATUS | MFP_SwitchToSecurityLevel3 |
| UFR_STATUS | MFP_AesAuthSecurityLevel1 |
| UFR_STATUS | MFP_ChangeMasterKey |
| UFR_STATUS | MFP_ChangeConfigurationKey |
| UFR_STATUS | MFP_FieldConfigurationSet |
| UFR_STATUS | MFP_ChangeSectorKey |
| UFR_STATUS | MFP_GetUid |
| UFR_STATUS | MFP_ChangeVcPollingEncKey |

| | |
|------------|---------------------------|
| UFR_STATUS | MFP_ChangeVcPollingMacKey |
|------------|---------------------------|

MFP_WritePerso**Function description**

Security level 0 command.

Function is used to change the data and AES keys from the initial delivery configuration to a customer specific value.

Function declaration (C language)

```
UFR_STATUS MFP_WritePerso(uint16_t address, uint8_t *data);
```

Parameters

| | |
|----------------|--------------------------|
| address | Number of block or key |
| *data | Value of data or AES key |

MFP_CommitPerso**Function description**

Security level 0 command.

Function is used to finalize the personalization and switch up to security level 1.

Function declaration (C language)

```
UFR_STATUS MFP_CommitPerso(void);
```

MFP_PersonalizationMinimal**Function description**

Security level 0 command.

Function is used for card personalization. The minimum number of AES keys is entered into the card. There are card master key, card configuration key, key for switch to security level 2, key for switch to security level 3, security level 1 authentication key, virtual card select key, proximity check key, VC polling ENC and VC polling MAC key. Keys can not be changed at security level 1.

Other keys that are not personalized will have value

0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF (16 x 0xFF)

Function declaration (C language)

```

UFR_STATUS MFP_PersonalizationMinimal(
    uint8_t *card_master_key,
    uint8_t *card_config_key,
    uint8_t *level_2_switch_key,
    uint8_t *level_3_switch_key,
    uint8_t *level_1_auth_key,
    uint8_t *select_vc_key,
    uint8_t *prox_chk_key,
    uint8_t *vc_poll_enc_key,
    uint8_t *vc_poll_mac_key);

```

Parameters

| | |
|----------------------------|---|
| *card_master_key | pointer to 16 byte array containing the card master key |
| *card_config_key | pointer to 16 byte array containing the card configuration key |
| *level_2_switch_key | pointer to 16 byte array containing the key for switch to security level 2 |
| *level_3_switch_key | pointer to 16 byte array containing the key for switch to security level 3 |
| *level_1_auth_key | pointer to 16 byte array containing the key for optional authentication at security level 1 |
| *select_vc_key | pointer to 16 byte array containing the key for virtual card selection |
| *prox_chk_key | pointer to 16 byte array containing the key for proximity check |
| *vc_poll_enc_key | pointer to 16 byte array containing the ENC key for virtual card polling |
| *vc_poll_mac_key | pointer to 16 byte array containing the MAC key for virtual card polling |

[MFP_AesAuthSecurityLevel1](#)
[MFP_AesAuthSecurityLevel1_PK](#)

Function description

Security level 1 command.

Security level 1 offers the same functionality as a MIFARE Classic card.

Function is used to optional AES authentication.

Function declaration (C language)

```
UFR_STATUS MFP_AesAuthSecurityLevel1(uint8_t key_index);
UFR_STATUS MFP_AesAuthSecurityLevel1_PK(uint8_t *aes_key);
```

Parameters

| | |
|------------------|--|
| key_index | ordinary number of AES key stored into reader (0 - 15) |
| *aes_key | pointer to 16 byte array containing the AES key |

MFP_SwitchToSecurityLevel3

MFP_SwitchToSecurityLevel3_PK

Function description

Security level 1 or 2 command.

Function is used to switch to security level 3.

Function declaration (C language)

```
UFR_STATUS MFP_SwitchToSecurityLevel3(uint8_t key_index);
UFR_STATUS MFP_SwitchToSecurityLevel3_PK(uint8_t *aes_key);
```

Parameters

| | |
|------------------|--|
| key_index | ordinary number of AES key stored into reader (0 - 15) |
| *aes_key | pointer to 16 byte array containing the AES key |

MFP_ChangeMasterKey

MFP_ChangeMasterKey_PK

MFP_ChangeMasterKeySamKey

Function description

Security level 3 command.

The function is used to change the AES card master key value.

Function declaration (C language)

```
UFR_STATUS MFP_ChangeMasterKey(uint8_t key_index, uint8_t *new_key);
UFR_STATUS MFP_ChangeMasterKey_PK(uint8_t *old_key, uint8_t *new_key);
```

*only uFR CS with SAM support

```
UFR_STATUS MFP_ChangeMasterKeySamKey(uint8_t key_index, uint8_t
new_key_index);
```

Parameters

| | |
|------------------|--|
| key_index | ordinary number of current master key stored into reader (0 - 15) or in SAM (1 - 127) |
| *old_key | pointer to 16 byte array containing the current master key |
| *new key | pointer to 16 byte array containing the new master key |

MFP_ChangeConfigurationKey

MFP_ChangeConfigurationKey_PK

MFP_ChangeConfigurationKeySamKey

Function description

Security level 3 command.

The function is used to change the AES card configuration key value.

Function declaration (C language)

```
UFR_STATUS MFP_ChangeConfigurationKey(uint8_t key_index,
                                       uint8_t *new_key);
UFR_STATUS MFP_ChangeConfigurationKey_PK(uint8_t *old_key,
                                       uint8_t *new_key);
```

*only uFR CS with SAM support

```
UFR_STATUS MFP_ChangeConfigurationKeySamKey(uint8_t key_index,
                                             uint8_t new_key_index);
```

Parameters

| | |
|------------------|---|
| key_index | ordinary number of current configuration key stored into reader (0 - 15) or in SAM (1 - 127) |
| *old_key | pointer to 16 byte array containing the current configuration key |
| *new key | pointer to 16 byte array containing the new configuration key |

MFP_FieldConfigurationSet
MFP_FieldConfigurationSet_PK
MFP_FieldConfigurationSetSamKey

Function description

Security level 3 command.

Function is used for definition of using Random ID and Proximity check options. Authentication with AES card configuration key required.

Function declaration (C language)

```
UFR_STATUS MFP_FieldConfigurationSet(
    uint8_t configuration_key_index,
    uint8_t rid_use,
    uint8_t prox_check_use);
UFR_STATUS DL_API MFP_FieldConfigurationSet_PK(
    uint8_t *configuration_key,
    uint8_t rid_use,
    uint8_t prox_check_use);

*only uFR CS with SAM support
UFR_STATUS DL_API MFP_FieldConfigurationSetSamKey(
    uint8_t configuration_key_index,
    uint8_t rid_use,
    uint8_t prox_check_use);
```

Parameters

| | |
|--------------------------------|---|
| configuration_key_index | ordinary number of configuration key stored into reader (0 - 15) |
| *configuration_key | pointer to 16 byte array containing the configuration key |
| rid_use | 1 - Random ID enabled, 0 - Random ID disabled |
| prox_check_use | 1- Proximity check is mandatory, 0 - Proximity check is not mandatory |

MFP_ChangeSectorKey
MFP_ChangeSectorKey_PK
MFP_ChangeSectorKeySamKey

Function description

Security level 3 command.

In order to access the block in sector data, AES authentication is needed. Each sector has two AES keys that can be used for authentication (Key A and Key B).

Default value if key is not personalized is 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF (16 x 0xFF).

For linear read part of card, enter the same value of sector keys for all sectors which will be read at once.

Function declaration (C language)

```
UFR_STATUS MFP_ChangeSectorKey(
    uint8_t sector_nr,
    uint8_t auth_mode,
    uint8_t key_index,
    uint8_t *new_key);

UFR_STATUS MFP_ChangeSectorKey_PK(
    uint8_t sector_nr,
    uint8_t auth_mode_pk,
    uint8_t *old_key,
    uint8_t *new_key);

*only uFR CS with SAM support

UFR_STATUS DL_API MFP_ChangeSectorKeySamKey(
    uint8_t sector_nr,
    uint8_t auth_mode,
    uint8_t key_index,
    uint8_t new_key_index);
```

Parameters

| | |
|---------------------|---|
| sector_nr | ordinary number of sector (0 - 31) for 2K card, or (0 - 39) for 4K card. |
| auth_mode | MIFARE_AUTHENT1A for Key A or MIFARE_AUTHENT1B for Key B |
| auth_mode_pk | MIFARE_PLUS_AES_AUTHENT1A for Key A or MIFARE_PLUS_AES_AUTHENT1B for Key B |
| key_index | ordinary number of current sector key stored into reader (0 - 15) |
| *old_key | pointer to 16 byte array containing the current sector key (A or B) |
| *new_key | pointer to 16 byte array containing the new sector key (A or B) |

[MFP_GetUid](#)

[MFP_GetUid_PK](#)

[MFP_GetUidSamKey](#)

Function description

Security level 3 command.

Function is used to read UID if Random ID is enabled. Authentication with AES VC Polling ENC Key and VC Polling MAC Key is mandatory.

Function declaration (C language)

```
UFR_STATUS MFP_GetUid(
    uint8_t key_index_vc_poll_enc_key,
    uint8_t key_index_vc_poll_mac_key,
    uint8_t *uid, uint8_t *uid_len);

UFR_STATUS MFP_GetUid_PK(
    uint8_t *vc_poll_enc_key,
    uint8_t *vc_poll_mac_key,
    uint8_t *uid, uint8_t *uid_len);
```

*only uFR CS with SAM support

```
UFR_STATUS MFP_GetUidSamKey(
    uint8_t key_index_vc_poll_enc_key,
    uint8_t key_index_vc_poll_mac_key,
    uint8_t *uid,
    uint8_t *uid_len);
```

Parameters

| | |
|----------------------------------|---|
| key_index_vc_poll_enc_key | ordinary number of VC polling ENC key stored into reader (0 - 15) |
| key_index_vc_poll_mac_key | ordinary number of VC polling MAC key stored into reader (0 - 15) |
| *vc_poll_enc_key | pointer to 16 byte array containing VC polling ENC key |
| *vc_poll_mac_key | pointer to 16 byte array containing VC polling MAC key |
| *uid | pointer to byte array containing the card UID |
| *uid_len | pointer to UID length variable |

[*MFP_ChangeVcPollingEncKey*](#)

[*MFP_ChangeVcPollingEncKey_PK*](#)

[*MFP_ChangeVcPollingEncKeySamKey*](#)

Function description

Security level 3 command.

The function is used to change the AES VC polling ENC key value. Authentication with AES card configuration key is required.

Function declaration (C language)

```

UFR_STATUS DL_API MFP_ChangeVcPollingEncKey(
    uint8_t configuration_key_index,
    uint8_t *new_key);
UFR_STATUS DL_API MFP_ChangeVcPollingEncKey_PK(
    uint8_t *configuration_key,
    uint8_t *new_key);

```

*only uFR CS with SAM support

```

UFR_STATUS DL_API MFP_ChangeVcPollingEncKeySamKey(
    uint8_t configuration_key_index,
    uint8_t new_key_index);

```

Parameters

| | |
|--------------------------------|---|
| configuration_key_index | ordinary number of card configuration key stored into reader (0 - 15) |
| *configuration_key | pointer to 16 byte array containing card configuration key |
| *new_key | pointer to 16 byte array containing new VC Polling ENC key |

[MFP_ChangeVcPollingMacKey](#)

[MFP_ChangeVcPollingMacKey_PK](#)

[MFP_ChangeVcPollingMacKeySamKey](#)

Function description

Security level 3 command.

The function is used to change the AES VC polling MAC key value. Authentication with AES card configuration key is required.

Function declaration (C language)

```

UFR_STATUS DL_API MFP_ChangeVcPollingMacKey(
    uint8_t configuration_key_index,
    uint8_t *new_key);
UFR_STATUS DL_API MFP_ChangeVcPollingMacKey_PK(
    uint8_t *configuration_key,
    uint8_t *new_key);

```

*only uFR CS with SAM support

```

UFR_STATUS DL_API MFP_ChangeVcPollingMacKeySamKey(
    uint8_t configuration_key_index,
    uint8_t new_key_index);

```

Parameters

| | |
|--------------------------------|---|
| configuration_key_index | ordinary number of card configuration key stored into reader (0 - 15) |
| *configuration_key | pointer to 16 byte array containing card configuration key |
| *new_key | pointer to 16 byte array containing new VC Polling MAC key |

Originality checking

Some card chips supports originality checking mechanism using Elliptic Curve Digital Signature Algorithm (ECDSA). Chip families that support originality checking mechanism are NTAG 21x and Mifare Ultralight EV1. For details on originality checking, you must have an non-disclosure agreement (NDA) with the manufacturer who will provide you with the relevant documentation. In any case, the uFR API provides you with 2 functions that you can use for this purpose:

ReadECCSignature**Function description**

This function returns ECC signature of the card chip UID. Card chip UID is signed using EC private key known only to a manufacturer.

Function declaration (C language)

```

#define MAX_UID_LEN      10
#define ECC_SIG_LEN      32
UFR_STATUS ReadECCSignature(uint8_t lpucECCSignature[ECC_SIG_LEN],
                           uint8_t lpucUid[MAX_UID_LEN],
                           uint8_t *lpucUidLen,
                           uint8_t *lpucDlogicCardType);

```

Parameters

| | |
|----------------------------|--|
| lpucECCSignature | pointer to array which (in case of successfully executed operation) will contain 32 bytes long ECDSA signature of the chip UID. Chip UID is signed using EC private key known only to a manufacturer. |
| lpucUid | pointer to a chip UID (in case of successfully executed operation). Returned here for convenience. |
| *lpucUidLen | pointer to variable which will (in case of successfully executed operation) receive true length of the returned UID. (Maximum UID length is 10 bytes but there is three possible UID sizes: 4, 7 and 10). |
| *lpucDlogicCardType | pointer to variable which will (in case of successfully executed operation) receive DlogicCardType. Returned here for convenience. For DlogicCardType uFR API uses the same constants as with GetDlogicCardType() function (see Appendix: DLogic CardType enumeration). |

OriginalityCheck**Function description**

This function depends on OpenSSL crypto library. Since OpenSSL crypto library is dynamically linked during execution, the only prerequisite for a successful call to this function is that the libeay32.dll is in the current folder (valid for Windows) and / or libcrypto.so is in the environment path (e.g. LD_LIBRARY_PATH on Linux / macOS). **OriginalityCheck()** performs the check if the chip on the card / tag is NXP genuine.

Function declaration (C language)

```
UFR_STATUS OriginalityCheck(const uint8_t *signature,
                           const uint8_t *uid,
                           uint8_t uid_len,
                           uint8_t DlogicCardType);
```

Parameters

| | |
|-----------------------|--|
| *signature | ECCSignature acquired by call to the ReadECCSignature() function. |
| *uid | Card UID. Best if the card UID is acquired by previous call to the ReadECCSignature() function. |
| uid_len | Card UID length. Best if the card UID length is acquired by previous call to the ReadECCSignature() function. |
| DlogicCardType | Card type. Best if the DlogicCardType is acquired by previous call to the ReadECCSignature() function. |

UFR_STATUS specific error codes that can be returned by this function:

| | | |
|------------------------------------|--------|---|
| UFR_NOT_NXP_GENUINE | 0x0200 | if the chip on the card/tag ISN'T NXP GENUINE |
| UFR_OPEN_SSL_DYNAMIC_LIB_FAILED | 0x0201 | in case of OpenSSL library error (e.g. wrong OpenSSL version) |
| UFR_OPEN_SSL_DYNAMIC_LIB_NOT_FOUND | 0x0202 | in case there is no OpenSSL library (libeay32.dll on Windows systems, libcrypto.so on Linux and libcrypto.dylib on macOS) in current folder or environment path |
| UFR_OK | 0 | if the chip on the card/tag IS NXP GENUINE |

NFC Type 2 Tags counters

There are different types of counters implemented in different families of the NFC T2T chips. Ultralight, NTAG 210 and NTAG 212 doesn't have counters.

Ultralight C and NTAG 203 have one 16-bit one-way counter which can be managed using BlockRead and BlockWrite API functions on the appropriate block address (for those two chips, counter page address is 0x29).

Ultralight EV1 variants have three independent 24-bit one-way counters which can be managed using ReadCounter() and IncrementCounter() API functions. Counters are mapped in a separate address space.

NTAG 213, NTAG 215 and NTAG 216 have 24-bit NFC counter which is incremented on every first valid occurrence of the READ or FAST-READ command (ISO 14443-3A proprietary

commands) after the tag is powered by an RF field. There is no another way to change value of the 24-bit NFC counter and there is mechanism to enable it or disable it. This counter can be read using `ReadNFCCounter()` API function if password authentication is not in use. API functions `ReadNFCCounterPwdAuth_RK()` or `ReadNFCCounterPwdAuth_PK()` can be used to read NFC counter if it's protected with the password authentication. 24-bit NFC counter have counter address 2 (counter is mapped in a separate address space) so `ReadCounter(2, &value)` call is equivalent to a `ReadNFCCounter(&value)` if password authentication isn't in use.

ReadCounter

Function description

This function is used to read one of the three 24-bit one-way counters in Ultralight EV1 chip family. Those counters can't be password protected. In the initial Ultralight EV1 chip state, the counter values are set to 0.

Function declaration (C language)

```
UFR_STATUS ReadCounter(uint8_t counter_address, uint32_t *value);
```

Parameters

| | |
|------------------------|--|
| counter_address | Address of the target counter. Can be in range 0 to 2. Counters are mapped in a separate address space. |
| *value | Pointer to a <code>uint32_t</code> which will contained counter value after successful function execution. Since counters are 24-bit in length, most significant byte of the <code>*value</code> will be always 0. |

IncrementCounter

Function description

This function is used to increment one of the three 24-bit one-way counters in Ultralight EV1 chip family. Those counters can't be password protected. If the sum of the addressed counter value and the increment value is higher than `0xFFFFFFFF`, the tag replies with an error and does not update the respective counter.

Function declaration (C language)

```
UFR_STATUS IncrementCounter(uint8_t counter_address, uint32_t inc_value);
```

Parameters

| | |
|------------------------|---|
| counter_address | Address of the target counter. Can be in range 0 to 2. Counters are mapped in a separate address space. |
| inc_value | Increment value. Only the 3 least significant bytes are relevant. |

ReadNFCCounter

Function description

This function is used to read 24-bit NFC counter in NTAG 213, NTAG 215 and NTAG 216 chips without using password authentication. If access to NFC counter is configured to be password protected, this function will return COUNTER_ERROR.

Function declaration (C language)

```
UFR_STATUS ReadNFCCounter(uint32_t *value);
```

Parameter

| | |
|---------------|--|
| *value | Pointer to a uint32_t which will contained counter value after successful function execution. Since counter is 24-bit in length, most significant byte of the *value will be always 0. |
|---------------|--|

ReadNFCCounterPwdAuth_RK

Function description

This function is used to read 24-bit NFC counter in NTAG 213, NTAG 215 and NTAG 216 chips using “reader key password authentication”. If access to NFC counter is configured to be password protected and PWD-PACK pair stored as a 6-byte key in uFR reader disagrees with PWD-PACK pair configured in tag, this function will return UFR_AUTH_ERROR. If access to NFC counter isn’t configured to be password protected, this function will return UFR_AUTH_ERROR.

Function declaration (C language)

```
UFR_STATUS ReadNFCCounterPwdAuth_RK(uint32_t *value,
                                     uint8_t reader_key_index);
```

Parameters

| | |
|---------------|--|
| *value | Pointer to a uint32_t which will contained counter value after successful function execution. Since counter is 24-bit in length, most significant byte of the *value will be always 0. |
|---------------|--|

| | |
|-------------------------|--|
| reader_key_index | Index of the 6-byte key (PWD-PACK pair for this type of NFC tags) stored in the uFR reader. Can be in range 0 to 31. |
|-------------------------|--|

ReadNFCCounterPwdAuth_PK

Function description

This function is used to read 24-bit NFC counter in NTAG 213, NTAG 215 and NTAG 216 chips using “provided key password authentication”. If access to NFC counter is configured to be password protected and PWD-PACK pair sent as a 6-byte provided key disagrees with PWD-PACK pair configured in tag, this function will return UFR_AUTH_ERROR. If access to NFC counter isn't configured to be password protected, this function will return UFR_AUTH_ERROR.

Function declaration (C language)

```
UFR_STATUS ReadNFCCounterPwdAuth_PK(uint32_t *value, const uint8_t *key);
```

Parameters

| | |
|---------------|--|
| *value | Pointer to a uint32_t which will contained counter value after successful function execution. Since counter is 24-bit in length, most significant byte of the *value will be always 0. |
| *key | Pointer to an array contains provided 6-byte key (PWD-PACK pair for this type of NFC tags) for password authentication. |

Functions for the operating parameters of the reader setting

UfrSetBadSelectCardNrMax

Function description

The function allows you to set the number of unsuccessful card selections before it can be considered that the card is not placed on the reader. Period between two card selections is approximately 10ms. Default value of this parameter is 20 i.e. 200ms. This parameter can be set in the range of 0 to 254.

This is useful for asynchronous card ID transmission, if parameter send_removed_enable in function SetAsyncCardIdSendConfig is set. Then you can set a lower value of the number of unsuccessful card selections, in order to send information to the card removed was faster. A small value of this parameter may cause a false report that the card is not present, and immediately thereafter true report that the card is present.

Function declaration (C language)

```
UFR_STATUS UfrSetBadSelectCardNrMax(uint8_t bad_select_nr_max);
```

Parameter

| | |
|--------------------------------|--|
| <code>bad_select_nr_max</code> | number of unsuccessful card selections |
|--------------------------------|--|

UfrGetBadSelectCardNrMax**Function description**

The function returns value of maximal unsuccessful card selections, which is set in reader.

Function declaration (C language)

```
UFR_STATUS UfrGetBadSelectCardNrMax(uint8_t *bad_select_nr_max);
```

Parameter

| | |
|--------------------------------|---|
| <code>bad_select_nr_max</code> | pointer to number of unsuccessful card selections |
|--------------------------------|---|

Functions for all blocks linear reading**Function description**

Functions allow you to quickly read data from the card including the sector trailer blocks. These functions are very similar to the functions for linear reading of users data space.

- ***LinearRowRead***
- ***LinearRowRead_AKM1***
- ***LinearRowRead_AKM2***
- ***LinearRowRead_PK***

Functions declaration (C language):

```

UFR_STATUS LinearRowRead(uint8_t *aucData,
                        uint16_t usLinearAddress,
                        uint16_t usDataLength,
                        uint16_t *lpusBytesReturned,
                        uint8_t ucAuthMode,
                        uint8_t ucReaderKeyIndex);

UFR_STATUS LinearRowRead_AKM1(uint8_t *aucData,
                             uint16_t usLinearAddress,
                             uint16_t usDataLength,
                             uint16_t *lpusBytesReturned,
                             uint8_t ucAuthMode);

UFR_STATUS LinearRowRead_AKM2(uint8_t *aucData,
                             uint16_t usLinearAddress,
                             uint16_t usDataLength,
                             uint16_t *lpusBytesReturned,
                             uint8_t ucAuthMode);

UFR_STATUS LinearRowRead_PK(uint8_t *aucData,
                           uint16_t usLinearAddress,
                           uint16_t usDataLength,
                           uint16_t *lpusBytesReturned,
                           uint8_t ucAuthMode,
                           uint8_t *aucProvidedKey);

```

Parameters

| | |
|--------------------------|--|
| aucData | Pointer to the sequence of bytes where read data will be stored |
| usLinearAddress | Linear address on the card from which the data want to read |
| usDataLength | Number of bytes for reading. For aucData a minimum usDataLength bytes must be allocated before calling the function |
| lpusBytesReturned | Pointer to "uint16_t" type variable, where the number of successfully read bytes from the card is written. If the reading is fully managed this data is equal to the usDataLength parameter. If there is an error reading some of the blocks, the function returns all successfully read data in the aucData before the errors occurrence and the number of successfully read bytes is returned via this parameter |
| ucAuthMode | This parameter defines whether to perform authentication with key A or key B. It can have two values, namely: AUTHENT1A (0x60) or AUTHENT1B (0x61) |
| ucReaderKeyIndex | The default method of authentication (when the functions without a |

| | |
|-----------------------|---|
| | suffix is used) performs the authenticity proving by using the selected key index from the reader. In the linear address mode, this applies to all sectors that are read |
| aucProvidedKey | Pointer to the six-byte string containing the key for authenticity proving in the "Provided Key" method. _PK Suffix in the name of the function indicates this method usage |

FUNCTIONS FOR READER LOW POWER MODE CONTROL

UfrEnterSleepMode

Function description

Function allows enter to reader low power working mode. Reader is in sleep mode. RF field is turned off. The reader is waiting for the command to return to normal working mode.

Function declaration (C language)

```
UFR_STATUS UfrEnterSleepMode(void);
```

UfrLeaveSleepMode

Function description

Function allows return from low power reader mode to normal working mode. This function wake up uFR, returning success status. Any other command returns COMMUNICATION_BREAK status.

Function declaration (C language):

```
UFR_STATUS UfrLeaveSleepMode(void);
```

AutoSleepSet

Function description

This function permanently set auto-sleep functionality of the device. Valid seconds_wait range is from 1 to 254. To permanently disable auto-sleep functionality use 0 or 0xFF for the seconds_wait parameter.

Function declaration (C language)

```
unsigned long AutoSleepSet(uint8_t seconds_wait);
```

Parameter

| | |
|---------------------|--|
| seconds_wait | device inactivity time before entering into sleep mode |
|---------------------|--|

AutoSleepGet

Function description

This function uses to get auto-sleep functionality setup from the device. You have to send pointer to already allocated variable of the `uint8_t` type. If auto-sleep functionality is disabled you will get 0 or 0xFF in the variable pointed by the `*seconds_wait` parameter.

Function declaration (C language)

```
unsigned long AutoSleepGet(uint8_t *seconds_wait);
```

Parameter

| | |
|---------------------------|--|
| <code>seconds_wait</code> | device inactivity time before entering into sleep mode |
|---------------------------|--|

Functions for Reader NTAG Emulation Mode

WriteEmulationNdef

Function description

Function store a message record for NTAG emulation mode in to the reader. Parameters of the function are: TNF, type of record, ID, payload. Maximum total size for emulated NDEF message is 144 bytes.

Function declaration (C language)

```
UFR_STATUS WriteEmulationNdef(uint8_t tnf,
                               uint8_t* type_record,
                               uint8_t type_length,
                               uint8_t* id,
                               uint8_t id_length,
                               uint8_t* payload,
                               uint8_t payload_length);
```

Parameters

| | |
|-----------------------------|--|
| <code>tnf</code> | TNF of the record |
| <code>type_record</code> | pointer to the array containing record type |
| <code>type_length</code> | length of the record type |
| <code>id</code> | pointer to the array containing record ID |
| <code>id_length</code> | length of the record ID |
| <code>payload</code> | pointer to the array containing record payload |
| <code>payload_length</code> | length of the record payload |

Possible error codes:

```
WRITE_VERIFICATION_ERROR = 0x70
```

```
MAX_SIZE_EXCEEDED = 0x10
```

WriteEmulationNdefWithAAR**Function description**

This function do the same as WriteEmulationNdef() function with the addition of an AAR embedded in to the NDEF message. AAR stands for “Android Application Record”. AAR is a special type of NDEF record that is used by Google’s Android operating system to signify to an NFC phone that an explicitly defined Android Application which should be used to handle an emulated NFC tag. Android App record will be added as the 2nd NDEF record in the NDEF message.

Function declaration (C language)

```
UFR_STATUS WriteEmulationNdefWithAAR(uint8_t tnf,
                                       uint8_t *type_record,
                                       uint8_t type_length,
                                       uint8_t *id,
                                       uint8_t id_length,
                                       uint8_t *payload,
                                       uint8_t payload_length,
                                       uint8_t *aar,
                                       uint8_t aar_length);
```

Parameters

| | |
|-----------------------|--|
| tnf | TNF of the record |
| type_record | pointer to the array containing record type |
| type_length | length of the record type |
| id | pointer to the array containing record ID |
| id_length | length of the record ID |
| payload | pointer to the array containing record payload |
| payload_length | length of the record payload |
| aar | pointer to the array containing AAR record |
| aar_length | length of the AAR record |

TagEmulationStart

Function description

Put the reader permanently in a NDEF tag emulation mode. Only way for a reader to exit from this mode is to receive the TAG_EMULATION_STOP command (issued by calling **TagEmulationStop()** function).

In this mode, the reader can only answer to the commands issued by a following library functions:

```
TagEmulationStart(),
WriteEmulationNdef(),
TagEmulationStop(),
GetReaderSerialNumber(),
GetReaderSerialDescription(),
GetReaderHardwareVersion(),
GetReaderFirmwareVersion(),
GetBuildNumber()
```

Calls to the other functions in this mode returns following error code:

```
FORBIDDEN_IN_TAG_EMULATION_MODE = 0x90
```

Function declaration (C language)

```
UFR_STATUS TagEmulationStart(void);
```

Possible error codes:

```
WRITE_VERIFICATION_ERROR = 0x70
```

(command resulting in a direct write to a device non-volatile memory)

TagEmulationStop

Function description

Allows the reader permanent exit from a NDEF tag emulation mode.

Function declaration (C language)

```
UFR_STATUS TagEmulationStop(void);
```

Possible error codes:

```
WRITE_VERIFICATION_ERROR = 0x70
```

(command resulting in a direct write to a device non-volatile memory)

WriteEmulationNdefRam

From library version 5.0.31, and firmware version 5.0.33

Function description

Function store a message record for NTAG emulation mode in to the reader in the RAM. Parameters of the function are: TNF, type of record, ID, payload. Maximum total size for emulated NDEF message is 1008 bytes. Unlike the function WriteEmulationNdef, the data is not written to the EEPROM of the reader, so they cannot be loaded after the reader reset. This function must call after reader reset to use the NTAG emulation.

Function declaration (C language)

```
UFR_STATUS WriteEmulationNdefRam(uint8_t tnf,
                                uint8_t* type_record,
                                uint8_t type_length,
                                uint8_t* id,
                                uint8_t id_length,
                                uint8_t* payload,
                                uint8_t payload_length);
```

Parameters

| | |
|----------------|--|
| tnf | TNF of the record |
| type_record | pointer to the array containing record type |
| type_length | length of the record type |
| id | pointer to the array containing record ID |
| id_length | length of the record ID |
| payload | pointer to the array containing record payload |
| payload_length | length of the record payload |

Possible error codes:

```
MAX_SIZE_EXCEEDED = 0x10
```

TagEmulationStartRam

From library version 5.0.31, and firmware version 5.0.33

Function description

Put the reader permanently in a NDEF tag in RAM emulation mode. Only way for a reader to exit from this mode is to receive the TAG_EMULATION_STOP command (issued by calling **TagEmulationStopRam()** function), or by reader reset. Use the function GetReaderStatus to check if the reader still in emulation mode (maybe reader was reset from some reason).

Function declaration (C language)

```
UFR_STATUS TagEmulationStartRam(void);
```

TagEmulationStopRam

From library version 5.0.31, and firmware version 5.0.33

Function description

Allows the reader permanent exit from a NDEF tag emulation mode.

Function declaration (C language)

```
UFR_STATUS TagEmulationStopRam(void);
```

Functions for setting Reader baud rates for ISO 14443 – 4A cards**SetSpeedPermanently****Function declaration (C language)**

```
UFR_STATUS SetSpeedPermanently(uint8_t tx_speed, uint8_t rx_speed);
```

Parameters

| | |
|-----------------|--------------------------------|
| tx_speed | setup value for transmit speed |
| rx_speed | setup value for receive speed |

Valid speed setup values are:

| Const | Configured speed |
|--------------|-------------------------|
| 0 | 106 kbps (default) |
| 1 | 212 kbps |
| 2 | 424 kbps |

On some reader types maximum rx_speed is 212 kbps. If you try to set higher speed than is allowed, reader firmware will automatically set the maximum possible speed.

Possible error codes:

```
WRITE_VERIFICATION_ERROR = 0x70
```

(command resulting in a direct write to a device non-volatile memory)

GetSpeedParameters

Function declaration (C language)

```
UFR_STATUS GetSpeedParameters(uint8_t* tx_speed, uint8_t* rx_speed);
```

Parameters

| | |
|-----------------|---|
| tx_speed | returns configured value for transmit speed |
| rx_speed | returns configured value for receive speed |

FUNCTIONS FOR DISPLAY CONTROL

SetDisplayData

Function description

Function enables sending data to the display. A string of data contains information about the intensity of color in each cell of the display. Each cell has three LED (red, green and blue). For each cell of the three bytes is necessary. The first byte indicates the intensity of the green color, the second byte indicates the intensity of the red color, and the third byte indicates the intensity of blue color. For example, if the display has 16 cells, an array contains 48 bytes. Value of intensity is in range from 0 to 255.

Function declaration (C language)

```
UFR_STATUS SetDisplayData(uint8_t *display_data,
                          uint8_t data_length);
```

Parameters

| | |
|---------------------|---------------------------|
| display_data | pointer to data array |
| data_length | number of data into array |

SetSpeakerFrequency

Function description

Function sets the frequency of the speaker. The speaker is working on this frequency until a new frequency setting. To stop the operation set frequency to zero.

Function declaration (C language)

```
UFR_STATUS SetSpeakerFrequency(uint16_t frequency);
```

Parameter

| | |
|------------------|-----------------|
| frequency | frequency in Hz |
|------------------|-----------------|

FUNCTIONS TO USE THE SHARED RAM INTO DEVICE

Shared RAM is memory space on a device that is used for communication between computer and Android device (phone, tablet) with an NFC reader. PC writes and read data from shared RAM via USB port. Device with Android OS writes and read data from shared RAM via NFC.

EnterShareRamCommMode**Function description**

Put reader permanently in the mode that use shared RAM. After execution of this function, must be executed function TagEmulationStart.

Function declaration (C language)

```
UFR_STATUS EnterShareRamCommMode(void);
```

ExitShareRamCommMode**Function description**

The permanent exit from mode that use shared RAM. After execution of this function, must be executed function TagEmulationStop.

Function declaration (C language)

```
UFR_STATUS EnterShareRamCommMode(void);
```

WriteShareRam**Function description**

Function allows writing data to the shared RAM.

Function declaration (C language)

```
UFR_STATUS WriteShareRam(uint8_t *ram_data,
                        uint8_t addr,
                        uint8_t data_len);
```

Parameters

| | |
|-----------------|---|
| ram_data | pointer to data array |
| addr | address of first data in an array |
| data_len | /length of array. Address + data_len <= 184 |

ReadShareRam**Function description**

Function allows read data from the shared RAM.

Function declaration (C language)

```
UFR_STATUS ReadShareRam(uint8_t *ram_data,
                       uint8_t addr,
                       uint8_t data_len);
```

Functions supporting Ad-Hoc emulation mode

This mode enables user controlled emulation from the user application. There is “nfc-rfid-reader-sdk/ufr-examples-ad_hoc_emulation-c” console example written in C, which demonstrate usage of this functions.

AdHocEmulationStart**Function description**

Put uFR in emulation mode with ad-hoc emulation parameters (see. SetAdHocEmulationParams() and GetAdHocEmulationParams() functions). uFR stays in ad-hoc emulation mode until AdHocEmulationStop() is called or reader reset.

Function declaration (C language)

```
UFR_STATUS AdHocEmulationStart(void);
```

AdHocEmulationStop**Function description**

Terminate uFR ad-hoc emulation mode.

Function declaration (C language)

```
UFR_STATUS AdHocEmulationStop(void);
```

GetExternalFieldState**Function description**

Returns external field state when uFR is in ad-hoc emulation mode.

Function declaration (C language)

```
UFR_STATUS GetExternalFieldState(uint8_t *is_field_present);
```

is_field_present contains 0 if external field isn't present or 1 if field is present.

GetAdHocEmulationParams**Function description**

This function returns current ad-hoc emulation parameters. On uFR power on or reset ad-hoc emulation parameters are set back to their default values.

Function declaration (C language)

```
UFR_STATUS GetAdHocEmulationParams(uint8_t *ThresholdMinLevel,
                                     uint8_t *ThresholdCollLevel,
                                     uint8_t *RFLevelAmp,
                                     uint8_t *RxGain,
                                     uint8_t *RFLevel);
```

Parameters

| | |
|---------------------------|--|
| ThresholdMinLevel | default value is 15. Could be in range from 0 to 15 |
| ThresholdCollLevel | default value is 7. Could be in range from 0 to 7 |
| RFLevelAmp | default value is 0. On uFR device should be 0 all the time. (1 for on, 0 for off). |
| RxGain | Could be in range from 0 to 7. |
| RFLevel | Could be in range from 0 to 15 |

SetAdHocEmulationParams**Function description**

This command set ad-hoc emulation parameters. On uFR power on or reset ad-hoc emulation parameters are set back to their default values.

Function declaration (C language)

```
UFR_STATUS SetAdHocEmulationParams(uint8_t ThresholdMinLevel,
                                   uint8_t ThresholdCollLevel,
                                   uint8_t RFLevelAmp,
                                   uint8_t RxGain,
                                   uint8_t RFLevel);
```

Parameters

| | |
|---------------------------|--|
| ThresholdMinLevel | default value is 15. Could be in range from 0 to 15 |
| ThresholdCollLevel | default value is 7. Could be in range from 0 to 7 |
| RFLevelAmp | default value is 0. On uFR device should be 0 all the time. (1 for on, 0 for off). |
| RxGain | Could be in range from 0 to 7. |
| RFLevel | Could be in range from 0 to 15 |

CombinedModeEmulationStart**Function description**

Puts the uFR reader into a permanently periodical switching from “NDEF tag emulation mode” to “tag reader mode”. Only way for a reader to exit from this mode is to receive the TAG_EMULATION_STOP command (issued by calling the TagEmulationStop() function).

Much better control of the NFC device in a uFR proximity range can be achieved using Ad-Hoc emulation mode, described before.

Function declaration (C language)

```
UFR_STATUS CombinedModeEmulationStart(void);
```

Function takes no parameters.

Support for ISO14443-4 protocol

The protocol defines three fundamental types of blocks:

- I-block used to convey information for use by the application layer.
- R-block used to convey positive or negative acknowledgements. An R-block never contains an INF field. The acknowledgement relates to the last received block.
- S-block used to exchange control information between the PCD and the PICC. There is two different types of S-blocks:
 - 1) Waiting time extension containing a 1 byte long INF field and
 - 2) DESELECT containing no INF field.

Function declaration (C language)

```
UFR_STATUS i_block_trans_rcv_chain(uint8_t chaining,
                                   uint8_t timeout,
                                   uint8_t block_length,
                                   uint8_t *snd_data_array,
                                   uint8_t *rcv_length,
                                   uint8_t *rcv_data_array,
                                   uint8_t *rcv_chained,
                                   uint32_t *ufr_status);
```

Parameters

| | |
|-----------------------|--|
| chaining | 1 – chaining in use, 0 – no chaining |
| timeout | timeout for card reply |
| block_length | inf block length |
| snd_data_array | pointer to array of data that will be send |
| rcv_length | length of received data |
| rcv_data_array | pointer to array of data that will be received |
| rcv_chained | 1 received packet is chained, 0 received packet is not chained |
| ufr_status | card operation status |

Function declaration (C language)

```
UFR_STATUS r_block_transceive(uint8_t ack,
                              uint8_t timeout,
                              uint8_t *rcv_length,
                              uint8_t *rcv_data_array,
                              uint8_t *rcv_chained,
                              uint32_t *ufr_status);
```

Parameters

| | |
|-----------------------|--|
| ack | 1 ACK, 0 NOT ACK |
| timeout | timeout for card reply |
| rcv_length | length of received data |
| rcv_data_array | pointer to array of data that will be received |
| rcv_chained | 1 received packet is chained, 0 received packet is not chained |
| ufr_status | card operation status |

Function declaration (C language)

```
UFR_STATUS s_block_deselect(uint8_t timeout);
```

Parameter

| | |
|----------------|-----------------|
| timeout | timeout in [ms] |
|----------------|-----------------|

Support for APDU commands in ISO 14443-4 tags

Some ISO 14443-4 tags supports the APDU message structure according to ISO/IEC 7816-4.

For more details you have to check the manual for the tags that you are planning to use.

Function declarations used to support APDU message structure:

```
UFR_STATUS SetISO14443_4_Mode(void) ;

UFR_STATUS SetISO14443_4_Mode_GetATS(uint8_t ats[MAX_ATS_LEN] ,
                                       uint8_t *ats_len,
                                       uint8_t uid[MAX_UID_LEN] ,
                                       uint8_t *uid_len,
                                       uint8_t *sak);
```

Parameters

| | |
|----------------|--|
| ats | After successful function execution, buffer on which this pointer points to will contain ATS returned from the TAG (historical bytes included). Before calling this function, you have to allocate MAX_ATS_LEN bytes for the ats buffer. MAX_ATS_LEN macro is defined in uFCoder.h (#define MAX_ATS_LEN 25). |
| ats_len | After successful function execution, variable on which this pointer points to will contain actual ATS length. |
| uid | After successful call to this function, buffer on which this pointer points to will contain TAG UID. Before calling this function, you have to allocate MAX_UID_LEN bytes for the ats buffer. MAX_UID_LEN macro is defined in uFCoder.h (#define MAX_UID_LEN 10). |
| uid_len | After successful function execution, variable on which this pointer points to will contain actual UID length. |
| sak | After successful function execution, variable on which this pointer points to will contain SAK (Select Acknowledge) of the TAG in field. |

```

UFR_STATUS uFR_APDU_Transceive(uint8_t cls,
                                uint8_t ins,
                                uint8_t p0,
                                uint8_t p1,
                                uint8_t *data_out,
                                uint8_t data_out_len,
                                uint8_t *data_in,
                                uint32_t max_data_in_len,
                                uint32_t *response_len,
                                uint8_t send_le,
                                uint8_t *apdu_status);

UFR_STATUS s_block_deselect(uint8_t timeout);

```

Parameters

| | |
|------------------------|---|
| cls | APDU CLA (class byte) |
| ins | APDU command code (instruction byte) |
| p0 | parameter byte |
| p1 | parameter byte |
| data_out | APDU command data field. Use NULL if data_out_len is 0 |
| data_out_len | number of bytes in the APDU command data field (Lc field) |
| data_in | buffer for receiving APDU response. There should be allocated at least (send_le + 2) bytes before function call. |
| max_data_in_len | size of the receiving buffer. If the APDU response exceeded size of buffer, then function returns error |
| response_len | value of the Le field if send_le is not 0. After successful execution location pointed by the response_len will contain number of bytes in the APDU response. |
| send_le | if this parameter is 0 then APDU Le field will not be sent. Otherwise Le field will be included in the APDU message. Value response_len pointed to, before function call will be value of the Le field. |
| apdu_status | APDU error codes SW1 and SW2 in 2 bytes array |

To send APDU message you must comply with the following procedure:

1. Call SetISO14443_4_Mode() or SetISO14443_4_Mode_GetATS(). ISO 14443-4 tag in a field will be selected and RF field polling will be stopped.
2. Call uFR_APDU_Transceive() as many times as you needed.

3. Call `s_block_deselect()` to deselect tag and restore RF field polling. This call is mandatory.

Fully uFR firmware support for APDU commands in ISO 14443-4 tags

This group of newly designed functions makes use of the `uFR_APDU_Transceive()` obsolete. However, `uFR_APDU_Transceive()` function is still part of the uFCoder library for backward compatibility.

New functions implemented in the uFCoder library are:

```
UFR_STATUS APDUHexStrTransceive(const char *c_apdu, char **r_apdu);
UFR_STATUS APDUPlainTransceive(const uint8_t *c_apdu,
                                uint32_t c_apdu_len,
                                uint8_t *r_apdu,
                                uint32_t *r_apdu_len);
UFR_STATUS APDUTransceive(uint8_t cls,
                           uint8_t ins,
                           uint8_t p0,
                           uint8_t p1,
                           const uint8_t *data_out,
                           uint32_t Nc,
                           uint8_t *data_in,
                           uint32_t *Ne,
                           uint8_t send_le,
                           uint8_t *apdu_status);
```

These functions are more responsive than obsolete `uFR_APDU_Transceive()`, because most of the work is performed by a uFR firmware.

```
UFR_STATUS APDUHexStrTransceive(const char *c_apdu, char **r_apdu);
```

Using this function, you can send C-APDU in the `c_string` (zero terminated) containing pairs of the hexadecimal digits. Pairs of the hexadecimal digits can be delimited by any of the punctuation characters or white space.

****r_apdu** returns pointer to the `c_string` (zero terminated) containing pairs of the hexadecimal digits without delimiters.

```
UFR_STATUS APDUPlainTransceive(const uint8_t *c_apdu,
                                uint32_t c_apdu_len,
                                uint8_t *r_apdu,
                                uint32_t *r_apdu_len);
```

This is binary alternative function to the `APDUHexStrTransceive()`. C-APDU and R-APDU are sent and receive in the form of the byte arrays. There is obvious need for a `c_apdu_len` and `*r_apdu_len` parameters which represents length of the `*c_apdu` and `*r_apdu` byte arrays, respectively.

The memory space on which `*r_apdu` points, have to be allocated before calling of the `APDUPlainTransceive()`. Number of the bytes allocated have to correspond to the N_e bytes,

defined by the L_e field in the C-APDU plus 2 bytes for SW1 and SW2.

```
UFR_STATUS APDUTransceive(uint8_t cls,
                           uint8_t ins,
                           uint8_t p0,
                           uint8_t p1,
                           const uint8_t *data_out,
                           uint32_t Nc,
                           uint8_t *data_in,
                           uint32_t *Ne,
                           uint8_t send_le,
                           uint8_t *apdu_status);
```

This is “exploded binary” alternative function intended for support APDU commands in ISO 14443-4A tags. **APDUTransceive()** receives separated parameters which are an integral part of the C-APDU. There is parameters **cls**, **ins**, **p0**, **p1** of the **uint8_t** type.

N_c defines number of bytes in the byte array ***data_out** point to. N_c also defines L_c field in the C-APDU. Maximum value for the N_c is 255. If $N_c > 0$ then $L_c = N_c$, otherwise L_c is omitted and ***data_out** can be NULL.

send_le and ***Ne** parameters defines L_e field in the C-APDU. If **send_le** is 1 then L_e field will be included in the C-APDU. If **send_le** is 0 then L_e field will be omitted from the C-APDU.

If ***Ne == 256** then $L_e = 0$, otherwise $L_e = *Ne$.

The memory space on which ***data_in**, have to be allocated before calling of the **APDUPlainTransceive()**. Number of the bytes allocated have to correspond to the ***Ne** bytes, defined by the L_e field in the C-APDU.

After successfully executed **APDUTransceive()**, ***data_in** will contain R-APDU data field (body).

***apdu_status** will contain R-APDU trailer (SW1 and SW2 APDU status bytes).

For older uFR firmware / deprecated / library backward compatibility

```
UFR_STATUS uFR_DESFIRE_Start(void);
```

```
UFR_STATUS uFR_DESFIRE_Stop(void);
```

```
UFR_STATUS uFR_APDU_Start(void);           // Alias for uFR_DESFIRE_Start()
```

```
UFR_STATUS uFR_APDU_Stop(void);           // Alias for uFR_DESFIRE_Stop()
```

```
UFR_STATUS      uFR_i_block_transceive(uint8_t      chaining,      uint8_t      timeout,
      uint8_t      block_length,      uint8_t      *snd_data_array,      size_t      *rcv_length,
      uint8_t      *rcv_data_array,      uint32_t      *ufr_status);
```

Support for ISO7816 protocol

uFR PLUS devices with SAM option only.

The device communicates via ISO7816 UART with the smart card located into mini smart card holder. Supports synchronous cards which do not use C4/C8.

open_ISO7816_interface

Function description

Function activates the smart card and returns ATR (Answer To Reset) array of bytes from smart card.

After the successfully executed function, the same APDU commands as for ISO14443-4 tags can be used, but not at the same time.

Function declaration (C language)

```
UFR_STATUS open_ISO7816_interface(uint8_t *atr_data, uint8_t *atr_len);
```

Parameters

| | |
|------------------|---------------------------------|
| *atr_data | pointer to array containing ATR |
| *atr_len | pointer to ATR length variable |

APDU_switch_to_ISO7816_interface

Function description

Function switches the use of APDU to ISO7816 interface. The smart card must be in the active state.

Function declaration (C language)

```
UFR_STATUS APDU_switch_to_ISO7816_interface(void);
```

close_ISO7816_interface_no_APDU

Function description

Function deactivates the smart card. APDU commands are not used.

Function declaration (C language)

```
UFR_STATUS close_ISO7816_interface_no_APDU(void);
```

close_ISO7816_interface_APDU_ISO14443_4

Function description

Function deactivates the smart card. APDU commands are used by ISO14443-4 tags. Tag must already be in ISO1443-4 mode.

Function declaration (C language)

```
UFR_STATUS close_ISO7816_interface_APDU_ISO14443_4(void);
```

APDU_switch_to_ISO14443_4_interface**Function description**

Function switches the use APDU to ISO14443-4 tags. The smart card stays in active state. Tag must already be in ISO1443-4 mode.

Function declaration (C language)

```
UFR_STATUS APDU_switch_to_ISO14443_4_interface(void);
```

APDU_switch_off_from_ISO7816_interface**Function description**

APDU commands are not used. The smart card stays in active state.

Function declaration (C language)

```
UFR_STATUS APDU_switch_off_from_ISO7816_interface(void);
```

Support for NXP SAM (Secure Application Module)

Two types of NXP SAM are supported: T1AD2060, and T1AR1070.

Only uFR Classic CS with SAM reader with firmware version 5.100.xx working with SAM.

SAM_get_version_raw**Function description**

Function returns manufacturing related data of the MIFARE SAM. For more information refer to NXP documentation.

Function declaration (C language)

```
UFR_STATUS SAM_get_version_raw(uint8_t *data, uint8_t *length);
```

Parameters

| | |
|----------------|--|
| *data | pointer to array containing version data |
| *length | pointer to length variable |

SAM_get_version

Function description

Function returns type of SAM, and 7 bytes UID.

Types of SAM are declared into structure:

```
typedef enum E_SAM_HW_VER {
    SAM_UNKNOWN_TYPE,
    SAM_T1AD2060_AV1_MODE ,
    SAM_T1AD2060_AV2_MODE,
    SAM_T1AR1070_AV1_MODE,
    SAM_T1AR1070_AV2_MODE
} SAM_HW_TYPE;
```

Function declaration (C language)

```
UFR_STATUS SAM_get_version(SAM_HW_TYPE *sam_type, uint8_t *sam_uid);
```

Parameters

| | |
|------------------|---|
| *sam_type | pointer to SAM type variable |
| *sam_uid | pointer to array containing 7 bytes UID |

SAM_get_key_entry_raw

Function description

Function allows reading the contents of the key entry specified in the parameter key_no. For more information refer to NXP documentation.

Function declaration (C language)

```
UFR_STATUS SAM_get_key_entry_raw(uint8_t key_no,
                                uint8_t *key_entry,
                                uint8_t *key_length,
                                uint8_t *apdu_sw);
```

Parameters

| | |
|--------------------|---|
| key_no | key reference number (0 - 127) |
| *key_entry | pointer to array containing key entry data |
| *key_length | pointer to key entry length variable |
| *apdu_sw | pointer to array containing SW1 and SW2 APDU status bytes |

SAM_authenticate_host_AV2_plain**Function description**

Function is used to run a mutual 3-pass authentication between the MIFARE SAM AV2 and PC. A host authentication is required to:

- Load or update keys into the MIFARE SAM AV2
- Activate the MIFARE SAM AV2 after reset (if configured accordingly in the configuration settings of master key key_no 00h)

The communication in this process is plain, so key will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_authenticate_host_AV2_plain(uint8_t *host_aes_key,
                                           uint8_t key_nr,
                                           uint8_t key_version,
                                           uint8_t *apdu_sw);
```

Parameters

| | |
|----------------------|---|
| *host_aes_key | pointer to array containing 16 bytes AES key |
| key_nr | key reference number (0 - 127) |
| key_version | key version (0 - 255) |
| *apdu_sw | pointer to array containing SW1 and SW2 APDU status bytes |

SAM_change_key_entry_aes_AV2_plain_host_key**Function description**

Function allows changing KST (Key Storage Table) containing 3 AES-128 keys, and their versions.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```

UFR_STATUS SAM_change_key_entry_aes_AV2_plain_host_key(
    uint8_t key_entry_no,
    uint8_t *aes_key_ver_a,
    uint8_t ver_a,
    uint8_t *aes_key_ver_b,
    uint8_t ver_b,
    uint8_t *aes_key_ver_c,
    uint8_t ver_c,
    uint8_t key_no_CEK,
    uint8_t key_v_CEK,
    uint8_t ref_no_KUC,
    uint8_t sam_lock_unlock,
    uint8_t sam_auth_host,
    uint8_t *apdu_sw);

```

Parameters

| | |
|------------------------|---|
| key_entry_no | key reference number (0 - 127) |
| *aes_key_ver_a | pointer to array containing 16 bytes of first AES key |
| ver_a | key version of first key (0 - 255) |
| *aes_key_ver_b | pointer to array containing 16 bytes of second AES key |
| ver_b | key version of second key (0 - 255) |
| *aes_key_ver_c | pointer to array containing 16 bytes of third AES key |
| ver_c | key version of third key (0 - 255) |
| key_no_CEK | reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number) |
| key_v_CEK | version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version) |
| ref_no_KUC | reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF) |
| sam_lock_unlock | SAM lock/unlock ability. If key_entry_no = 0 (master key), then the SAM will be locked after power up or reset, and minimal set of commands will be available. |
| sam_auth_host | Host authentication ability. If key_entry_no = 0 (master key), then the authentication with host key is mandatory after power up or reset, in opposition minimal set of commands will be available. |
| *apdu_sw | pointer to array containing SW1 and SW2 APDU status bytes |

SAM_change_key_entry_mifare_AV2_plain_one_key

Function description

Function allows changing KST containing two Crypto 1 keys (KeyA and KeyB) for authentication to Mifare Classic or Mifare Plus card in SL1 mode.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_mifare_AV2_plain_one_key(
    uint8_t key_entry_no,
    uint8_t *keyA,
    uint8_t *keyB,
    uint8_t key_no_CEK,
    uint8_t key_v_CEK,
    uint8_t ref_no_KUC,
    uint8_t *apdu_sw);
```

Parameters

| | |
|---------------------|--|
| key_entry_no | key reference number (1 - 127) |
| *keyA | pointer to array containing 6 bytes Crypto 1 key A |
| *keyB | pointer to array containing 6 bytes Crypto 1 key B |
| key_no_CEK | reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number) |
| key_v_CEK | version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version) |
| ref_no_KUC | reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF) |
| *apdu_sw | pointer to array containing SW1 and SW2 APDU status bytes |

SAM_change_key_entry_AES_AV2_plain_one_key

Function description

Function allows changing KST containing AES key for authentication to Mifare Desfire or Mifare Plus card in SL3 mode.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_AES_AV2_plain_one_key(
    uint8_t key_entry_no,
    uint8_t *key,
    uint8_t key_no_CEK,
    uint8_t key_v_CEK,
    uint8_t ref_no_KUC,
    uint8_t *apdu_sw);
```

Parameters

| | |
|---------------------|--|
| key_entry_no | key reference number (1 - 127) |
| *key | pointer to array containing 16 bytes of AES key |
| key_no_CEK | reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number) |
| key_v_CEK | version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version) |
| ref_no_KUC | reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF) |
| *apdu_sw | pointer to array containing SW1 and SW2 APDU status bytes |

SAM_change_key_entry_3K3DES_AV2_plain_one_key**Function description**

Function allows changing KST containing 3K3DES key for authentication to Mifare Desfire card.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```

UFR_STATUS SAM_change_key_entry_3K3DES_AV2_plain_one_key(
    uint8_t key_entry_no,
    uint8_t *key,
    uint8_t key_no_CEK,
    uint8_t key_v_CEK,
    uint8_t ref_no_KUC,
    uint8_t *apdu_sw);

```

Parameters

| | |
|---------------------|--|
| key_entry_no | key reference number (1 - 127) |
| *key | pointer to array containing 24 bytes of 3K3DES key |
| key_no_CEK | reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number) |
| key_v_CEK | version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version) |
| ref_no_KUC | reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF) |
| *apdu_sw | pointer to array containing SW1 and SW2 APDU status bytes |

SAM_change_key_entry_DES_AV2_plain_one_key**Function description**

Function allows changing KST containing DES key for authentication to Mifare Desfire card.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_DES_AV2_plain_one_key(
    uint8_t key_entry_no,
    uint8_t *key,
    uint8_t key_no_CEK,
    uint8_t key_v_CEK,
    uint8_t ref_no_KUC,
    uint8_t *apdu_sw);
```

Parameters

| | |
|---------------------|--|
| key_entry_no | key reference number (1 - 127) |
| *key | pointer to array containing 8 bytes of DES key |
| key_no_CEK | reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number) |
| key_v_CEK | version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version) |
| ref_no_KUC | reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF) |
| *apdu_sw | pointer to array containing SW1 and SW2 APDU status bytes |

SAM_change_key_entry_2K3DES_ULC_AV2_plain_one_key**Function description**

Function allows changing KST containing 2K3DES key for authentication to Ultralight C card.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```

UFR_STATUS SAM_change_key_entry_2K3DES_ULC_AV2_plain_one_key(
    uint8_t key_entry_no,
    uint8_t *key,
    uint8_t key_no_CEK,
    uint8_t key_v_CEK,
    uint8_t ref_no_KUC,
    uint8_t *apdu_sw);

```

Parameters

| | |
|---------------------|--|
| key_entry_no | key reference number (1 - 127) |
| *key | pointer to array containing 16 bytes of 2K3DES key |
| key_no_CEK | reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number) |
| key_v_CEK | version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version) |
| ref_no_KUC | reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF) |
| *apdu_sw | pointer to array containing SW1 and SW2 APDU status bytes |

SAM_change_key_entry_2K3DES_desfire_AV2_plain_one_key**Function description**

Function allows changing KST containing 2K3DES key for authentication to Mifare Desfire card.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_2K3DES_desfire_AV2_plain_one_key(
    uint8_t key_entry_no,
    uint8_t *key,
    uint8_t key_no_CEK,
    uint8_t key_v_CEK,
    uint8_t ref_no_KUC,
    uint8_t *apdu_sw);
```

Parameters

| | |
|---------------------|--|
| key_entry_no | key reference number (1 - 127) |
| *key | pointer to array containing 16 bytes of 2K3DES key |
| key_no_CEK | reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number) |
| key_v_CEK | version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version) |
| ref_no_KUC | reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF) |
| *apdu_sw | pointer to array containing SW1 and SW2 APDU status bytes |

WriteSamUnlockKey**Function description**

If master key has enabled lock/unlock parameter, then SAM unlock with key with lock/unlock ability is required. uFR reader tries to unlock SAM with key which stored into reader by this function. If internal reader keys locked, then they must be unlocked first, with function ReaderKeysUnlock.

The communication in this process is plain, so key will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS DL_API WriteSamUnlockKey(uint8_t key_no,
    uint8_t key_ver,
    uint8_t *aes_key);
```

Parameters

| | |
|-----------------|---|
| key_no | key reference number (0 - 127) |
| key_ver | key version (0 - 255) |
| *aes_key | pointer to array containing 16 bytes of AES key |

Java Card Application (JCAApp)

JCAApp stands for Java Card Application. By the "Java Card" term we refer to a contactless or dual interface Java Cards. For now, we have supported two JCAApps in our uFR Series NFC API. Those JCAApps are DLSigner and DLStorage.

PIN codes implemented on the Java Card Applications

DLSigner JCAApp have mandatory PIN codes implemented. DLStorage JCAApp have optional PIN codes implemented.

PIN code is an abbreviation of "Personal Identification Number". JCAApps that have PIN codes implemented, contains 2 different PIN codes. These are SO (Security Officer) PIN and User PIN code. The so-called "Security Officer" is actually a user who have administrative privileges for accessing security objects on the JCAApps and rights to write files. SO PIN code should be different from the User PIN code.

"Security Officer" is required to be logged in to access the card in cases when it is necessary to change the PIN and PUK codes and to change files, keys and / or certificates. Logging in with an User PIN code is necessary to get digital signature of a hashed data string.

PIN codes on the JCAApps can have a minimum of 4 characters and a maximum of 8 characters. Here, under the character there is any alphanumerical (case sensitive) or any printable character. Printable characters mainly refer to punctuation marks on the standard keyboards. When changing PIN codes, it is not recommended the use of specific characters that can be found only on individual localized keypads, but only characters that are in ASCII standard and that exist on standard US English keyboards.

In all of the JCAApps, the default SO PIN and User PIN codes are set initially, consisting of eight consecutive numerical characters '0' (zero) or "00000000". The maximum number of incorrect consecutive PIN code entered is 5. If the number of incorrect successive attempts to enter the PIN code is exceeded, that PIN code is blocked. While the PIN code is not blocked, entering the correct PIN code resets the incorrectly entered PIN codes counter. The only way to unblock your PIN is to enter the correct PUK code. PUK is the abbreviation of "PIN Unlock Key". SO PUK code serves exclusively to unblock SO PIN code and user PUK to unblock user PIN code. In the case of 10 consecutive incorrectly entered PUK codes, the PUK code becomes unusable, and the functionality on which the blocked PIN code relates, remains blocked forever.

Common JCAApp PIN functions

JCAAppLogin

Function description

This function is used to login to the JCAApp with an appropriate PIN code. Every time you deselect the JCAApp tag either by calling `s_block_deselect()`, `ReaderReset()`, `ReaderClose()` or because of the loss of the NFC field, in order to communicate with the same tag you have to select JCAApp and login again, using this function.

Every successful login resets the incorrectly entered PIN code counter for the PIN code specified by the SO parameter.

Function declaration (C language)

```
UFR_STATUS JCAAppLogin(uint8_t SO, uint8_t *pin, uint8_t pinSize);
```

Parameters

| | |
|----------------|---|
| SO | If this parameter have value 0 function will try to login as a User . If this parameter have value different then 0, function will try to login as a Security Officer (SO) . |
| pin | Pointer to the array of bytes which contains PIN code. |
| pinSize | Effective size of the array of bytes which contains PIN code. |

JCAAppGetPinTriesRemaining

Function description

This function is used to get how many of the unsuccessful login attempts remains before specified PIN or PUK code will be blocked.

This function have parametar of the type `dl_sec_code_t` which is defined as:

```
typedef enum {
    USER_PIN = 0,
    SO_PIN,
    USER_PUK,
    SO_PUK
} dl_sec_code_t;
```

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCAAppGetPinTriesRemaining(dl_sec_code_t secureCodeType,
                                      uint16_t *triesRemaining);
```

Parameters

| | |
|-----------------------|--|
| secureCodeType | Specifies the PIN code type (see the dl_sec_code_t type definition above, in the text) |
| triesRemaining | Pointer to the 16-bit unsigned integer which will contain the number of the unsuccessful login attempts remains before specified PIN code will be blocked, in case of succesifful function execution. If this value is 0 then the specified PIN code is blocked. |

JCAAppPinChange**Function description**

This function is used to change the PIN or PUK code which type is specified with secureCodeType parameter of type dl_sec_code_t which is defined as:

```
typedef enum {
    USER_PIN = 0,
    SO_PIN,
    USER_PUK,
    SO_PUK
} dl_sec_code_t;
```

Prior calling this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCAAppPinChange(dl_sec_code_t secureCodeType,
                           uint8_t *newPin,
                           uint8_t newPinSize);
```

Parameters

| | |
|-----------------------|--|
| secureCodeType | Specifies the PIN or PUK code type you wish to change (see the dl_sec_code_t type definition above, in the text) |
| newPin | Pointer to the array of bytes which contains a new code. |
| newPinSize | Effective size of the array of bytes which contains a new code. |

JCAAppPinUnblock**Function description**

This function is used to unblock PIN code which is specified by the **SO parameter**.

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCAAppPinUnblock(uint8_t SO, uint8_t *puk, uint8_t pukSize);
```

Parameters

| | |
|----------------|--|
| SO | If this parameter have value 0 function will try to unblock User PIN code. If this parameter have value different then 0, function will try to unblock SO PIN code. |
| puk | Pointer to the array of bytes which contains PUK code. |
| pukSize | Effective size of the array of bytes which contains PUK code. |

PKI infrastructure and digital signature support**Fully supported from library version 4.3.8 and firmware version 3.9.55**

In our product range, we have special cards called DLSigner JCAApp, which contains support for PKI infrastructure and digital signing. To invoke API functions that support these features, the following conditions must be met:

1. DLSigner JCAApp card must be in uFR reader field.
2. NFC tag must be in ISO 14443-4 mode. For entering ISO 14443-4 mode use **SetISO14443_4_Mode()** or **SetISO14443_4_Mode_GetATS()** function.
3. Now you can call any of the API functions with prefix "JCAApp" as much as necessary.
4. At the end of JCAApp session is necessary to call **s_block_deselect()** to deselect tag and restore RF field polling.

To generate digital signature using DLSigner JCAApp you need to have at least one of the private keys stored in a card. Further, if your data for signing have more than 255 bytes, you have to split them into the chunks and send them to a card using JCAAppSignatureBegin() for the first chunk and JCAAppSignatureUpdate() for rest of the chunks. To generate signature, you have to call JCAAppSignatureEnd() after you have sent all of the data for signing. At last, to get signature, you have to call JCAAppGetSignature().

If your data for signing have 255 bytes or less, it is sufficient to call JCAAppGenerateSignature() only once and immediately after that call JCAAppGetSignature() to get a signature.

DLSigner requires usage of the SO (security officer) PIN and User PIN codes. More about DLSigner you can find in a document "uFR digital signing and verification tools".

JCAAppSelectByAid**Function description**

Using this function you can select appropriate application on the card. For the DLSigner JCAApp AID should be 'F0 44 4C 6F 67 69 63 00 01'. For the DLStorage JCAApp AID should be 'F0 44 4C 6F 67 69 63 01 01'. Before calling this function, NFC tag must be in ISO 14443-4 mode. For entering ISO 14443-4 mode use SetISO14443_4_Mode() or SetISO14443_4_Mode_GetATS() function.

Function declaration (C language)

```
UFR_STATUS JCAAppSelectByAid(const uint8_t *aid,
                             uint8_t aid_len,
                             uint8_t selection_response[16]);
```

Parameters

| | |
|---------------------------|--|
| aid | Pointer to array containing AID (Aplication ID) i.e: "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01" for the DLSigner or "\xF0\x44\x4C\x6F\x67\x69\x63\x01\x01" for the DLStorage JCAApp. |
| aid_len | Length of the AID in bytes (9 for the DLSigner or DLStorage JCAApps). |
| selection_response | On Application successful selection, card returns 16 bytes. In current version only the first of those bytes (i.e. byte with index 0) is relevant and contains JCAApp card type which is 0xA0 for actual revision. |

JCAAppPutPrivateKey**Function description**

In JCAApp cards you can put two types of asymmetric crypto keys. Those are RSA and ECDSA private keys, three of each. Before you can use JCAApp card for digital signing you have to put appropriate private key in it. There is no way to read out private keys from the card.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAApp should be selected using JCAAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

This feature is disabled in the regular DLSigner JCAApp. To acquire cards with this feature enabled you have to contact your supplier with a special request.

Prior calling this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCAAppPutPrivateKey(uint8_t key_type,
                               uint8_t key_index,
                               const uint8_t *key,
                               uint16_t key_bit_len,
                               const uint8_t *key_param,
                               uint16_t key_parm_len);
```

Parameters

| | |
|---------------------|---|
| key_type | 0 for RSA private key and 1 for ECDSA private key. |
| key_index | For each of the card types there is 3 different private keys that you can set. Their indexes are from 0 to 2. |
| key | Pointer to array containing key bytes. |
| key_bit_len | Key length in bits . |
| key_param | Reserved for future use (RFU). Use null for this parameter. |
| key_parm_len | Reserved for future use (RFU). Use 0 for this parameter. |

JCAAppSignatureBegin**Function description**

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAApp should be selected using JCAAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Function declaration (C language)

```
UFR_STATUS JCAAppSignatureBegin(uint8_t cipher,
                                uint8_t digest,
                                uint8_t padding,
                                uint8_t key_index,
                                const uint8_t *chunk,
                                uint16_t chunk_len,
                                const uint8_t *alg_param,
                                uint16_t alg_parm_len);
```

Parameters

| | |
|---------------------|---|
| cipher | 0 for the RSA private key and 1 for the ECDSA. |
| digest | 0 for none digest (not supported with ECDSA) and 1 for SHA1 |
| padding | 0 for none (not supported with RSA) and 1 for pads the digest according to the PKCS#1 (v1.5) scheme. |
| key_index | For each of the card types there is 3 different private keys that you can set. Their indexes are from 0 to 2. |
| chunk | Pointer to array containing first chunk of data. |
| chunk_len | Length of the first chunk of data (max. 255). |
| alg_param | Reserved for future use (RFU). Use null for this parameter. |
| alg_parm_len | Reserved for future use (RFU). Use 0 for this parameter. |

JCAAppSignatureUpdate**Function description**

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAApp should be selected using JCAAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Function declaration (C language)

```
UFR_STATUS JCAAppSignatureUpdate(const uint8_t *chunk,
                                uint16_t chunk_len);
```

Parameters

| | |
|------------------|---|
| chunk | Pointer to an array containing current one of the remaining chunks of data. |
| chunk_len | Length of the current one of the remaining chunks of data (max. 255). |

JCAppSignatureEnd

Function description

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Function declaration (C language)

```
UFR_STATUS JCAppSignatureEnd(uint16_t *sig_len);
```

Parameters

| | |
|----------------|--|
| sig_len | Pointer to a 16-bit value in which you will get length of the signature in case of successful executed chain of function calls, described in introduction of this topic. |
|----------------|--|

JCAppGenerateSignature

Function description

This function virtually combines three successive calls of functions JCAppSignatureBegin(), JCAppSignatureUpdate() and JCAppSignatureEnd() and can be used in case your data for signing have 255 bytes or less.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Prior calling this function you have to be logged in with an User PIN code.

Function declaration (C language)

```
UFR_STATUS JCAAppGenerateSignature(uint8_t cipher,
                                   uint8_t digest,
                                   uint8_t padding,
                                   uint8_t key_index,
                                   const uint8_t *plain_data,
                                   uint16_t plain_data_len,
                                   uint16_t *sig_len,
                                   const uint8_t *alg_param,
                                   uint16_t alg_parm_len);
```

Parameters

| | |
|-----------------------|---|
| cipher | 0 for the RSA private key and 1 for the ECDSA. |
| digest | 0 for none digest (not supported with ECDSA) and 1 for SHA1 |
| padding | 0 for none (not supported with RSA) and 1 for pads the digest according to the PKCS#1 (v1.5) scheme. |
| key_index | For each of the card types there is 3 different private keys that you can set. Their indexes are from 0 to 2. |
| plain_data | Pointer to array containing data for signing. |
| plain_data_len | Length of the data for signing (max. 255). |
| sig_len | Pointer to a 16-bit value in which you will get length of the signature in case of successful execution. |
| alg_param | Reserved for future use (RFU). Use null for this parameter. |
| alg_parm_len | Reserved for future use (RFU). Use 0 for this parameter. |

JCAAppGetSignature**Function description**

At last, to get signature, you have to call JCAAppGetSignature().

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAApp should be selected using JCAAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Prior calling of this function you have to be logged in with an User PIN code.

Function declaration (C language)

```
UFR_STATUS JCApGetSignature(uint8_t *sig,
                             uint16_t sig_len);
```

Parameters

| | |
|----------------|--|
| sig | Pointer to an array of “sig_len” bytes length. Value of the “sig_len” you've got as a parametar of the JCApSignatureEnd() or JCApGenerateSignature() functions. You have to allocate those bytes before calling this function. |
| sig_len | Length of the allocated bytes in a sig array. |

JCApPutObj**Function description**

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAp should be selected using JCApSelectByAid() with AID = “\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01”.

Prior calling this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCApPutObj(uint8_t obj_type,
                      uint8_t obj_index,
                      uint8_t *obj,
                      int16_t obj_size,
                      uint8_t *id,
                      uint8_t id_size);
```

Parameters

| | |
|------------------|--|
| obj_type | 0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority). |
| obj_index | For each of the certificates containing RSA or ECDSA public keys there is 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there is 12 memory slots so there indexes can be from 0 to 11. |
| obj | Pointer to an array containing object (certificate). |
| obj_size | Length of the object (certificate). |
| id | Pointer to an array containing object id . Object id is a symbolic value and have to be unique on the card. |
| id_size | Length of the object id . Minimum object id length can be 1 and maximum 253. |

JCAAppPutObjSubject

Function description

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAApp should be selected using JCAAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Prior calling of this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCAAppPutObjSubject(uint8_t obj_type,
                                uint8_t obj_index,
                                uint8_t *subject,
                                uint8_t size);
```

Parameters

| | |
|------------------|--|
| obj_type | 0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority). |
| obj_index | For each of the certificates containing RSA or ECDSA public keys there is 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there is 12 memory slots so there indexes can be from 0 to 11. |
| subject | Pointer to an array containing subject. Subject is a symbolic value linked to a appropriate certificate by the same obj_type and index. |
| size | Length of the subject. Maximum subject length is 255. |

JCAAppInvalidateCert

Function description

Using this function you can delete certificate object from a card. This include subjects linked to a certificate.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAApp should be selected using JCAAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Prior calling this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCApInvalidateCert(uint8_t obj_type,
                               uint8_t obj_index);
```

Parameters

| | |
|------------------|--|
| obj_type | 0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority). |
| obj_index | For each of the certificates containing RSA or ECDSA public keys there is 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there is 12 memory slots so there indexes can be from 0 to 11. |

JCApGetObjId**Function description**

This function you always have to call 2 times. Before first call you have to set parameter **id** to **null** and you will get **id_size** of the obj_type at obj_index. Before second call you have to allocate an array of the returned **id_size** bytes and pass that array using parameter **id**. Before second call, ***id_size** should be set to a value of the exact bytes allocated.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAp should be selected using JCApSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCApGetObjId(uint8_t obj_type,
                        uint8_t obj_index,
                        uint8_t *id,
                        uint16_t *id_size);
```

Parameters

| | |
|------------------|--|
| obj_type | 0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority). |
| obj_index | For each of the certificates containing RSA or ECDSA public keys there is 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there is 12 memory slots so there indexes can be from 0 to 11. |
| id | When id == NULL, function returns id_size. |
| id_size | Before second call, *id_size should be set to a value of the exact bytes allocated. |

JCAAppGetObjSubject

Function description

This function you always have to call 2 times. Before first call you have to set parameter **subject** to **null** and you will get **size** of the obj_type at obj_index. Before second call you have to allocate array of returned **size** bytes and pass that array using parameter **subject**. Before second call, ***size** should be set to a value of the exact bytes allocated.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAApp should be selected using JCAAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCAAppGetObjSubject(uint8_t obj_type,
                                uint8_t obj_index,
                                uint8_t *subject,
                                uint16_t *size);
```

Parameters

| | |
|------------------|--|
| obj_type | 0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority). |
| obj_index | For each of the certificates containing RSA or ECDSA public keys there is 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there is 12 memory slots so there indexes can be from 0 to 11. |
| subject | When subject == NULL, function returns size. |
| size | Before second call, *size should be set to a value of the exact bytes allocated. |

JCAAppGetObj

Function description

This function you always have to call 2 times. Before first call you have to set parameter **obj** to **null** and you will get **size** of the obj_type at obj_index. Before second call you have to allocate array of returned **size** bytes and pass that array using parameter **obj**. Before second call, ***size** should be set to a value of the exact bytes allocated.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCAApp should be selected using JCAAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCApplGetObj(uint8_t obj_type,
                        uint8_t obj_index,
                        uint8_t *obj,
                        int16_t size);
```

Parameters

| | |
|------------------|--|
| obj_type | 0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority). |
| obj_index | For each of the certificates containing RSA or ECDSA public keys there is 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there is 12 memory slots so there indexes can be from 0 to 11. |
| obj | When obj == NULL, function returns size. |
| size | Before second call, *size should be set to a value of the exact bytes allocated. |

DLStorage JCAApp support

Fully supported from library version 5.0.8 and firmware version 5.0.20

DLStorage supports up to 16 files on the card and each of those files can be up to 32 KB in size, limited by the overall size of the card. This JCAApp support fast reading mechanism utilizing Extended APDU case 2E and “water-level” PCD reading algorithm in the uFR firmware. For now there is one model - DLStorage 30 with 40KB of storage size. With the DLStorage App you can optionally use two different PIN codes: one for writing operations and a different one for reading operations.

JCStorageGetFilesListSize

Function description

This function have to be called before JCStorageListFiles() to acquire size of the array of bytes needed to be allocated for the list of currently existing files on the DLStorage card. Maximum files on the DLStorage card is 16.

Function declaration (C language)

```
UFR_STATUS JCStorageGetFilesListSize(uint32_t *list_size);
```

Parameters

| | |
|------------------|--|
| list_size | Pointer to the 32-bit unsigned integer which will contain size of the array of bytes needed to be allocated prior calling the JCStorageListFiles() function. |
|------------------|--|

JCStorageListFiles

Function description

After calling the JCStorageGetFilesListSize() function and getting size of the list of the currently existing files on the DLStorage card, and if the list size greater than 0, you can allocate convenient array of bytes and then call this function. On successful function execution, the array pointed by the list parameter will contain indexes of the existing files on the card. Maximum files on the DLStorage card is 16. Each byte of the array pointed by the list parameter contain single index of the existing file on the DLStorage card.

Function declaration (C language)

```
UFR_STATUS JCStorageListFiles(uint8_t *list,
                              uint32_t list_bytes_allocated);
```

Parameters

| | |
|-----------------------------|--|
| list | Pointer to the allocated array of bytes of the size acquired by the previous call to JCStorageGetFilesListSize() function. |
| list_bytes_allocated | Size of the array of bytes pointed by the list parameter. Have to be equal to the value of the *list_size acquired by the previous call to JCStorageGetFilesListSize() function. |

JCStorageGetFileSize**Function description**

This function returns file size indexed by the parameter `card_file_index`, on successful execution. Returned file size is in bytes. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15. You have to know file size to allocate appropriate amount of data prior calling JCStorageReadFile() function.

Function declaration (C language)

```
UFR_STATUS JCStorageGetFileSize(uint8_t card_file_index,
                                uint32_t *file_size);
```

Parameters

| | |
|------------------------|---|
| card_file_index | It should contain an index of the file which size we want to get. |
| file_size | Pointer to the 32-bit unsigned integer which will contain size in bytes of the file having <code>card_file_index</code> . |

JCStorageReadFile**Function description**

After calling the JCStorageGetFileSize() function and getting the size of the file on the DLStorage card you can allocate convenient array of bytes and then call this function. On successful function execution, the array pointed by the data parameter will contain file content. If the file with the index defined by the `card_file_index` parameter does not exist, function will return UFR_APDU_SW_FILE_NOT_FOUND (0x000A6A82) error code. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15.

Function declaration (C language)

```
UFR_STATUS JCStorageReadFile(uint8_t card_file_index,
                             uint8_t *data,
                             uint32_t data_bytes_allocated);
```

Parameters

| | |
|-----------------------------|--|
| card_file_index | It should contain an index of the file we want to read. |
| data | Pointer to the allocated array of bytes of the size acquired by the previous call to JCStorageGetFileSize() function. |
| data_bytes_allocated | Size of the array of bytes pointed by the data parameter. Have to be equal to the value of the *file_size acquired by the prior calling JCStorageGetFileSize() function. |

JCStorageReadFileToFileSystem**Function description**

This function read file from the DLStorage card directly to the new file on the host file-system. If the file on the host file system already exists, it will be overwritten. If the file with the index defined by the card_file_index parameter does not exist, function will return UFR_APDU_SW_FILE_NOT_FOUND (0x000A6A82) error code. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15.

Function declaration (C language)

```
UFR_STATUS JCStorageReadFileToFileSystem(uint8_t card_file_index,
                                          const char *file_system_path_name);
```

Parameters

| | |
|------------------------------|---|
| card_file_index | It should contain an index of the file we want to read. |
| file_system_path_name | Pointer to the null-terminated string that should contain path and the name of the new file on the host file-system which will contain the data read from the file on the card in case of successfull function execution. |

JCStorageWriteFile**Function description**

This function create file on the DLStorage card and write array of bytes pointed by the data parameter to it. Parameter data_size define amount of data to be written in the file on the DLStorage card. If the file with the index defined by the card_file_index parameter already exists on the card, function will return UFR_APDU_SW_ENTITY_ALREADY_EXISTS (0x000A6A89) error code. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15. If there is an error during the writing procedure, for example because of the loss of the NFC field and the file is only partially written (tearing event), corrupted file on the DLStorage card should be deleted and then written again. Therefore we suggest you to always do verification of the data written to the card.

Function declaration (C language)

```
UFR_STATUS JCStorageWriteFile(uint8_t card_file_index,
                              const uint8_t *data,
                              uint32_t data_size);
```

Parameters

| | |
|------------------------|---|
| card_file_index | It should contain an index of the file we want to create and write data to it. |
| data | Pointer to the data i.e. array of bytes to be written in to the new file on the card. |
| data_size | Size, in bytes, of the data to be written in to the file on the card. |

JCStorageWriteFileFromFileSystem**Function description**

This function write file content from the host file-system to the new file on the DLStorage card. If the file with the index defined by the `card_file_index` parameter already exists on the card, function will return `UFR_APDU_SW_ENTITY_ALREADY_EXISTS` (0x000A6A89) error code. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15. If there is an error during the writing procedure, for example because of the loss of the NFC field and the file is only partially written (tearing event), corrupted file on the DLStorage card should be deleted and then written again. Therefore we suggest you to always do verification of the data written to the card.

Function declaration (C language)

```
UFR_STATUS JCStorageWriteFileFromFileSystem(uint8_t card_file_index,
                                             const char *file_system_path_name);
```

Parameters

| | |
|------------------------------|--|
| card_file_index | It should contain an index of the file on the card we want to create and write content of the file from the host file-sistem to it. |
| file_system_path_name | Pointer to the null-terminated string that should contain path and the name of the file from the host file-sistem whose content we want to transfer to the new file on the card. |

JCStorageDeleteFile**Function description**

After successful call to this function, file on the DLStorage card will be deleted. Maximum files on the card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15. If file with index defined by the `file_index` parameter does not exist, function will return `UFR_APDU_SW_FILE_NOT_FOUND` (0x000A6A82) error code.

Function declaration (C language)

```
UFR_STATUS JCStorageDeleteFile(uint8_t file_index);
```

Parameters

| | |
|-------------------|---|
| file_index | It should contain an index of the file we want to delete. |
|-------------------|---|

General purpose cryptographic functions**DLGetHashName****Function description**

This function returns pointer to a null terminated string constant which contains the name of the hash algorithm designated by the input function parameter.

Function declaration (C language)

```
c_string DLGetHashName(uint32_t hash_algo);
```

Parameters

| | |
|------------------|--|
| hash_algo | Hash designator. Use values declared in E_HASH_ALGS enumeration. |
|------------------|--|

DLGetEccCurveName**Function description**

This function returns pointer to a null terminated string constant which contains the name of the ECC curve designated by the input function parameter.

Function declaration (C language)

```
c_string DLGetEccCurveName(uint32_t eccCurve);
```

Parameters

| | |
|-----------------|--|
| eccCurve | ECC curve designator. Use values declared in E_ECC_CURVES enumeration. |
|-----------------|--|

DLGetSignatureSchemeName**Function description**

This function returns pointer to a null terminated string constant which contains the name of the signature scheme (signature algorithm) designated by the input function parameter.

Function declaration (C language)

```
c_string DLGetSignatureSchemeName(uint32_t signatureScheme);
```

Parameters

| | |
|------------------------|--|
| signatureScheme | Signature scheme (signature algorithm) designator. Use values declared in E_SIGNATURE_SCHEMES enumeration. |
|------------------------|--|

Cryptographic hashing algorithms*DLGetHashOutputByteLength***Function description**

This function used to get hash output length in bytes for specified hash algorithm.

Function declaration (C language)

```
UFR_STATUS DLGetHashOutputByteLength(uint32_t hash_algo,
                                       uint32_t *out_byte_len);
```

Parameters

| | |
|---------------------|---|
| hash_algo | Hash designator for which we want to get output length in bytes. Use values declared in E_HASH_ALGS enumeration. |
| out_byte_len | After successful function execution, variable on which this pointer points to, will contain output hash length in bytes for specified hash algorithm. |

*DLGetHash***Function description**

This function calculate and return hash of the data in the buffer pointed by the “in” function parameter. Hash algorithm is specified by the **hash_algo** function parameter.

If output bytes doesn't match with hash_allocated function parameter function returns CRYPTO_SUBSYS_WRONG_HASH_OUTPUT_LENGTH status.

Function declaration (C language)

```
UFR_STATUS DLGetHash(uint32_t hash_algo,
                     IN const uint8_t *in,
                     uint32_t in_len,
                     OUT uint8_t *hash,
                     uint32_t hash_allocated);
```

Parameters

| | |
|-----------------------|---|
| hash_algo | Hash designator. Use values declared in E_HASH_ALGS enumeration. |
| in | Input buffer of which hash is calculated. |
| in_len | Input buffer length in bytes. Maximum buffer length is 32 KB. If you have more data, use chunked hashing method (see usage instructions of the DLHashInitChunked() , DLHashUpdateChunked() and DLHashFinishChunked() functions). |
| hash | After successful function execution, variable on which this pointer points to, will contain output hash. |
| hash_allocated | This parameter should contain number of bytes previously allocated in the hash buffer. This parameter have to be greater or equal to output length of the hash algorithm which is specified by the hash_algo parameter. |

DLGetHashToHeap**Function description**

This function calculate and return hash of the data in the buffer pointed by the “**in**” function parameter. Hash algorithm is specified by the **hash_algo** function parameter.

If output bytes doesn't match with **hash_allocated** function parameter function returns CRYPTO_SUBSYS_WRONG_HASH_OUTPUT_LENGTH status.

GetHashToHeap() automatically allocates memory, which *hash parameter will points to after successful execution. User is obligated to cleanup allocated memory space, occupied by the *hash, after use (e.g. by calling DLFree() or directly free() from the C/C++ code).

Function declaration (C language)

```
UFR_STATUS DLGetHashToHeap(uint32_t hash_algo,
                           const uint8_t *in,
                           uint32_t in_len,
                           uint8_t **hash,
                           uint32_t *hash_len);
```

Parameters

| | |
|------------------|---|
| hash_algo | Hash designator which specifies the hash algorithm used for calculation. Use values declared in E_HASH_ALGS enumeration. |
| in | Input buffer of which hash is calculated. |
| in_len | Input buffer length in bytes. Maximum buffer length is 32 KB. If you have more data, use chunked hashing method (see usage instructions of the DLHashInitChunked() , DLHashUpdateChunked() and DLHashFinishChunked() functions). |
| hash | After successful function execution, variable on which this pointer points to, will contain the pointer to the output hash. |
| hash_len | After successful function execution, variable on which this pointer points to, will contain output hash length. |

DLHashInitChunked**Function description**

This function is used in conjunction with **DLHashUpdateChunked()** and **DLHashFinishChunked()** or **DLHashFinishChunkedToHeap()** functions.

These functions have the same result as the single call to **DLGetHash()** or **DLGetHashToHeap()** functions but they are used for larger amounts of data to hash.

These functions have to be called in the specific sequence. Disruption of the calling sequence leads to unpredictable results. In every hashing sequence, **DLHashInitChunked()** have to be called exactly once, in the beginning of the sequence. After successful hashing sequence initialization, there can be as many as needed **DLHashUpdateChunked()** calls. Chunk sizes may vary throughout the sequence. At the end of the sequence there can be exactly one call to either **DLHashFinishChunked()** or **DLHashFinishChunkedToHeap()** function. These two functions differ only in that the **DLHashFinishChunkedToHeap()** automatically allocates space for a resulting hash while the **DLHashFinishChunked()** expects to store the result in an already allocated memory on the heap. Calling one of **DLHashFinishChunked()** or **DLHashFinishChunkedToHeap()** functions finishes current hashing sequence.

Function declaration (C language)

```
UFR_STATUS DLHashInitChunked(uint32_t hash_algo);
```

Parameters

| | |
|------------------|--|
| hash_algo | Hash designator which specifies the hash algorithm used in the following hashing sequence. Use values declared in E_HASH_ALGS enumeration. |
|------------------|--|

DLHashUpdateChunked**Function description**

This function is used in conjunction with **DLHashInitChunked()** and **DLHashFinishChunked()** or **DLHashFinishChunkedToHeap()** functions.

These functions have the same result as the single call to **DLGetHash()** or **DLGetHashToHeap()** functions but they are used for larger amounts of data to hash.

These functions have to be called in the specific sequence. Disruption of the calling sequence leads to unpredictable results. In every hashing sequence, **DLHashInitChunked()** have to be called exactly once, in the beginning of the sequence. After successful hashing sequence initialization, there can be as many as needed **DLHashUpdateChunked()** calls. Chunk sizes may vary throughout the sequence. At the end of the sequence there can be exactly one call to either **DLHashFinishChunked()** or **DLHashFinishChunkedToHeap()** function. These two functions differ only in that the **DLHashFinishChunkedToHeap()** automatically allocates space for a resulting hash while the **DLHashFinishChunked()** expects to store the result in an already allocated memory on the heap. Calling one of **DLHashFinishChunked()** or **DLHashFinishChunkedToHeap()** functions finishes current hashing sequence.

Function declaration (C language)

```
UFR_STATUS DLHashUpdateChunked(IN const uint8_t *in, uint32_t in_len);
```

Parameters

| | |
|---------------|--|
| in | One of the chunks of data of which hash is calculated. |
| in_len | Chunk length in bytes. |

DLHashFinishChunked**Function description**

This function is used in conjunction with **DLHashInitChunked()** and **DLHashUpdateChunked()** functions.

These functions have the same result as the single call to **DLGetHash()** or **DLGetHashToHeap()** functions but they are used for larger amounts of data to hash.

These functions have to be called in the specific sequence. Disruption of the calling sequence

leads to unpredictable results. In every hashing sequence, `DLHashInitChunked()` have to be called exactly once, in the beginning of the sequence. After successful hashing sequence initialization, there can be as many as needed `DLHashUpdateChunked()` calls. Chunk sizes may vary throughout the sequence. At the end of the sequence there can be exactly one call to either `DLHashFinishChunked()` or `DLHashFinishChunkedToHeap()` function. These two functions differ only in that the `DLHashFinishChunkedToHeap()` automatically allocates space for a resulting hash while the `DLHashFinishChunked()` expects to store the result in an already allocated memory on the heap. Calling one of `DLHashFinishChunked()` or `DLHashFinishChunkedToHeap()` functions finishes current hashing sequence.

Function declaration (C language)

```
UFR_STATUS DLHashFinishChunked(OUT uint8_t *hash,
                               uint32_t hash_allocated);
```

Parameters

| | |
|-----------------------|---|
| hash | After successful function execution, variable on which this pointer points to, will contain output of the hashing sequence. |
| hash_allocated | This parameter should contain number of bytes previously allocated in the hash buffer. This parameter have to be greater or equal to the output length of the hash algorithm which is specified by the hash_algo parameter passed in the previous call to the <code>DLHashInitChunked()</code> , in the beginning of the hashing sequence. |

DLHashFinishChunkedToHeap

Function description

This function is used in conjunction with `DLHashInitChunked()` and `DLHashUpdateChunked()` functions.

These functions have the same result as the single call to `DLGetHash()` or `DLGetHashToHeap()` functions but they are used for larger amounts of data to hash.

These functions have to be called in the specific sequence. Disruption of the calling sequence leads to unpredictable results. In every hashing sequence, `DLHashInitChunked()` have to be called exactly once, in the beginning of the sequence. After successful hashing sequence initialization, there can be as many as needed `DLHashUpdateChunked()` calls. Chunk sizes may vary throughout the sequence. At the end of the sequence there can be exactly one call to either `DLHashFinishChunked()` or `DLHashFinishChunkedToHeap()` function. These two functions differ only in that the `DLHashFinishChunkedToHeap()` automatically allocates space for a resulting hash while the `DLHashFinishChunked()` expects to store the result in an already allocated memory on the heap. Calling one of `DLHashFinishChunked()` or `DLHashFinishChunkedToHeap()` functions finishes current hashing sequence.

`DLHashFinishChunkedToHeap()` automatically allocates memory, which `*hash` parameter will

points to, after successful execution. User is obligated to cleanup allocated memory space, occupied by the *hash, after use (e.g. by calling `DLFree(cert)` or directly `free(cert)` from the C/C++ code).

Function declaration (C language)

```
UFR_STATUS DLHashFinishChunkedToHeap(uint8_t **hash,
                                     uint32_t *hash_len);
```

Parameters

| | |
|-----------------|--|
| hash | After successful function execution, variable on which this pointer points to, will contain the pointer to the output of the hashing sequence. |
| hash_len | After successful function execution, variable on which this pointer points to, will contain output hash length. |

DLFree

Function description

Release the memory allocated from the some of the library functions previously called making it available again for further allocations. Use to deallocate i.e. cleanup memory on the heap allocated. This function is so called helper for programming languages other than C/C++ where you can use a `free(ptr)` instead. Use only after calling the library functions for which it is explicitly indicated in this manual. Function returns nothing. After successful function execution ptr will point to NULL.

Function declaration (C language)

```
void DLFree(void *ptr);
```

Parameters

| | |
|------------|--|
| ptr | Pointer to the memory allocated on the heap which you want to release. If ptr does not point to a block of memory allocated with the library functions, it causes undefined behavior. If ptr is NULL, the function does nothing. |
|------------|--|

Digital signature verification

Enumerations, types and structures for use with *DigitalSignatureVerifyHash* function

```
enum E_ECC_CURVE_DEFINITION_TYPES {
    ECC_CURVE_INDEX,
    ECC_CURVE_NAME,
    ECC_CURVE_DOMAIN_PARAMETERS,
    ECC_CURVE_DEFINITION_TYPES_NUM
};
```

```
typedef struct {
    uint32_t ecc_curve_field_type;
    void *field_domain_params;
} ecc_curve_domain_params_t;

typedef struct {
    uint32_t ecc_curve_definition_type;
    uint32_t ecc_curve_index;
    char *ecc_curve_name;
    ecc_curve_domain_params_t *ecc_curve_domain_params;
} ecc_key_param_t;
```

DigitalSignatureVerifyHash

Function description

This function is used to verify digital signature of the pre-hashed value or some relatively short plain text message. If there is no errors during verification process and digital signature correspond to the "To Be Signed" (TBS) data array and public cryptographic key, function returns **UFR_OK** status. "To Be Signed" is just a colloquial term for already signed data, which is the origin of the digital signature.

In case of wrong digital signature, function returns **CRYPTO_SUBSYS_WRONG_SIGNATURE** status.

Function can return following status codes in case of various errors:

- CRYPTO_SUBSYS_NOT_INITIALIZED
- CRYPTO_SUBSYS_INVALID_HASH_ALGORITHM
- CRYPTO_SUBSYS_INVALID_PADDING_ALGORITHM
- CRYPTO_SUBSYS_INVALID_CIPHER_ALGORITHM
- CRYPTO_SUBSYS_INVALID_SIGNATURE_PARAMS
- CRYPTO_SUBSYS_INVALID_RSA_PUB_KEY
- CRYPTO_SUBSYS_INVALID_ECC_PUB_KEY
- CRYPTO_SUBSYS_INVALID_ECC_PUB_KEY_PARAMS
- CRYPTO_SUBSYS_UNKNOWN_ECC_CURVE
- CRYPTO_SUBSYS_SIGNATURE_VERIFICATION_ERROR

For digest_alg use one of the values declared in E_SIGNER_DIGESTS enumeration:


```
enum E_SIGNER_DIGESTS {
    ALG_NULL = 0,
    ALG_SHA,
    ALG_SHA_256,
    ALG_SHA_384,
    ALG_SHA_512,
    ALG_SHA_224,
    ALG_SHA_512_224,
    ALG_SHA_512_256,

    SIG_DIGEST_MAX_SUPPORTED
};
```

ALG_SHA is designator for the SHA-1 algorithm.

For padding_alg use one of the values declared in E_SIGNER_RSA_PADDINGS enumeration:

```
enum E_SIGNER_RSA_PADDINGS {
    PAD_NULL = 0,
    PAD_PKCS1_V1_5,
    PAD_PKCS1_PSS,

    SIG_PAD_MAX_SUPPORTED
};
```

PAD_PKCS1 is an alias of the PAD_PKCS1_V1_5 padding algorithm:

```
#define PAD_PKCS1    PAD_PKCS1_V1_5
```

For cipher_alg use one of the values declared in E_SIGNER_CIPHERS enumeration:

```
enum E_SIGNER_CIPHERS {
    SIG_CIPHER_RSA = 0,
    SIG_CIPHER_ECDSA,

    SIG_CIPHER_MAX_SUPPORTED
};
```

When the signer cipher algorithm is SIG_CIPHER_ECDSA, padding_alg is ignored and you can freely use PAD_NULL i.e. value 0 as a padding_alg. ECDSA data alignment in use is described in [RFC6979](#) (section 2.3. - Integer Conversions).

Function declaration (C language)

```
UFR_STATUS DigitalSignatureVerifyHash(uint32_t digest_alg,
                                     uint32_t padding_alg,
                                     uint32_t cypher_alg,
                                     const uint8_t *tbs,
                                     uint32_t tbs_len,
                                     const uint8_t *signature,
                                     uint32_t signature_len,
                                     const void *sig_params,
                                     uint32_t sig_params_len,
                                     const uint8_t *pub_key,
                                     uint32_t pub_key_len,
                                     const void *pub_key_params,
                                     uint32_t pub_key_params_len);
```

Parameters

| | |
|-----------------------|---|
| digest_alg | in the E_SIGNER_DIGESTS enumeration. |
| padding_alg | in the E_SIGNER_RSA_PADDINGS enumeration. When the signer cipher algorithm is SIG_CIPHER_ECDSA, padding_alg is ignored and you can freely use PAD_NULL i.e. value 0 as a padding_alg. ECDSA data alignment in use is described in RFC6979 (section 2.3. - Integer Conversions). |
| cypher_alg | in the E_SIGNER_CIPHERS enumeration. |
| tbs | Pointer to the "To Be Signed" data array i.e. hash or relatively short plain text message whose digital signature is being verified. "To Be Signed" is just a colloquial term for already signed data, which is the origin of the digital signature. |
| tbs_len | Length of the "To Be Signed" array (in bytes). |
| signature | Pointer to the signature array. |
| signature_len | Length of the signature array (in bytes). |
| sig_params | Pointer to the additional signature parameters. Additional signature parameters is in use only when padding_alg is PAD_PKCS1_PSS and in that case this pointer should points to the unsigned 4-byte integer containing the value of the cryptographic salt length. |
| sig_params_len | Length of the additional signature parameters (in bytes). Additional signature parameters is in use only when padding_alg is PAD_PKCS1_PSS and in that case this value should be 4 i.e. size of unsigned 4-byte integer. In other cases this parameter is ignored. |
| pub_key | Pointer to the public key array. In case of RSA public key, this array should contain key modulus ('N'). |

| | |
|---------------------------|--|
| pub_key_len | Length of the public key parameter pub_key (in bytes). |
| pub_key_params | Pointer to the additional public key parameters. In case of RSA public key, this array should contain public key exponent array ('e'). In case of ECC public key, this array should contain elliptic curve definition array. To set elliptic curve definition array you can use SetEllipticCurveByIndex() or SetEllipticCurveByName() functions. |
| pub_key_params_len | Length of the additional public key parameters (in bytes). |

Machine Readable Travel Documents (MRTD) support

Fully supported from library version 5.0.12 and firmware version 5.0.22

Extended support (including MRTD validity verification) from library version 5.0.25 and firmware version 5.0.22

The uFCoder library from version 5.0.12 supports “Machine Readable Travel Documents” (MRTD hereinafter), mainly ePassports. MRTD specification is maintained by the “International Civil Aviation Organization” (ICAO) and publish it in Doc 9303. eMRTD have embedded NFC tag which mandatory contains general information about the document holder, encoded facial image of the document holder and digital signatures of the containing data. Optionally embedded NFC tag may additionally contain fingerprints and eyes data with advanced security options. Advanced security options are not supported yet. In the embedded NFC tag data is stored in file logical structures. Files are named EF.DGx where EF stands for “elementary file” and DG stands for “data group”. For more details please read the ICAO MRTD specification (<http://icao.int>)

Authentication to the NFC tag embedded in a eMRTD and secure communication protocol can be established using different methods. For now, uFCoder library supports only Basic Access Control (BAC). Other possible secure communication protocols and authentication methods are Password Authenticated Connection Establishment (PACE) and optional Extended Access Control.

To read eMRTD data using Basic Access Control (BAC), first we have to get data from the so called ‘Machine Readable Zone’ (MRZ). Data of interest are document number, document holder date of birth and document expiration date. Document number is always 9 characters long. Dates have to be in a “**YYMMDD**” format. In order to get MRZ Proto Key needed in subsequent steps, you can chose to enter MRZ data of interest using `MRTD_MRZDataToMRZProtoKey()` function or to enter MRZ subjacent row (only for TD3 MRZ format) using `MRTD_MRZSubjacentToMRZProtoKey()` function. Example of the TD3 MRZ format printed on the eMRTD document looks like this:

P<UTOERIKSSON<<ANNA<MARIA<<<<<<<<<<<<<<<<
L898902C36UTO7408122F1204159ZE184226B<<<<10

and, in this case, MRTD MRZSubjacentToMRZProtoKey() function should receive pointer to null

In order to get MRZ Proto Key needed in subsequent steps, you can call this function and pass it

```

IER STATUS MPID MPZDataToMPZProtoKey/const char *doc_number

```

[illegible]

In order to get MR7 Proto Key needed in subsequent steps in case of the TD3 MR7 format (88

11. *Journal of the American Medical Association*, 2000; 283: 2689-2696.

5. 4. 1. 1. 1. (21. 01. 2019)

```
UFR_STATUS MRTD_MRZSubjacentToMRZProtoKey(
    const char *mrz,
    uint8_t mrz_proto_key[25]);
```

Parameters

| | |
|----------------------|---|
| mrz | Pointer to a null terminated string containing MRZ data. According to ICAO Doc 9303-10, there it has three MRZ data formats: TD1,TD2 or TD3 formats. TD1 contains exactly 90 characters, TD2 contains exactly 72 characters and TD3 contains exactly 88 characters. |
| mrz_proto_key | This byte array will contain calculated MRZ proto-key after successful function execution. This array must have allocated at least 25 bytes prior calling this function. |

MRTD_MRZSubjacentCheck

Function description

This function checks subjacent row of a MRZ data integrity. Integrity check uses a special check digits calculation. The check digits permit readers to verify that data in the MRZ is correctly interpreted. If the all of the check digits and composite check digit passed the verification process, this function returns UFR_OK status. Otherwise the function returns MRTD_MRZ_CHECK_ERROR status.

Function declaration (C language)

```
UFR_STATUS MRTD_MRZSubjacentCheck(const char *mrz);
```

Parameters

| | |
|------------|---|
| mrz | Pointer to a null terminated string containing MRZ data. According to ICAO Doc 9303-10, there it has three MRZ data formats: TD1,TD2 or TD3 formats. TD1 contains exactly 90 characters, TD2 contains exactly 72 characters and TD3 contains exactly 88 characters. |
|------------|---|

MRTDAppSelectAndAuthenticateBac

Function description

Use this function to authenticate to the eMRTD NFC tag using BAC. This function establish security channel for communication. Security channel is maintained using send_sequence_cnt parameter and channel session keys are ksenc (for encryption) and ksmac (for calculating MAC).

Function declaration (C language)

```

UFR_STATUS MRTDAppSelectAndAuthenticateBac(
    const uint8_t mrz_proto_key[25],
    uint8_t ksenc[16],
    uint8_t ksmac[16],
    uint64_t *send_sequence_cnt);

```

Parameters

| | |
|--------------------------|---|
| mrz_proto_key | MRZ proto-key acquired using prior call to MRTD_MRZDataToMRZProtoKey() or MRTD_MRZSubjacentToMRZProtoKey() function. |
| ksenc | This array must have allocated at least 16 bytes prior calling this function. This array will contain session encryption key after successful function execution. |
| ksmac | This array must have allocated at least 16 bytes prior calling this function. This array will contain session key for calculating MAC after successful function execution. |
| send_sequence_cnt | After successful execution of this function, pointer to this 64-bit value should be saved and forwarded at every subsequent call to MRTDFileReadBacToHeap() and/or other functions for reading eMRTD. |

MRTDFileReadBacToHeap

Function description

Use this function to read files from the eMRTD NFC tag. You can call this function only after successfully established security channel by the previously called MRTDAppSelectAndAuthenticateBac() function. Session keys ksenc and ksmac, and also parameter send_sequence_cnt are acquired by the previously called MRTDAppSelectAndAuthenticateBac() function. After the successful call to this function, *output points to the file data read from a eMRTD file specified by the file_index parameter. Buffer, in which the data is stored, is automatically allocated on memory heap during function execution. Maximum amount of data allocated can be 32KB. There is programmer responsibility to cleanup allocated data (i.e. by calling free(), the standard C function) after use (e.g. by calling DLFree(cert) or directly free(cert) from the C/C++ code).

Function declaration (C language)

```

UFR_STATUS MRTDFileReadBacToHeap(const uint8_t *file_index,
                                  uint8_t **output,
                                  uint32_t *output_length,
                                  const uint8_t ksenc[16],
                                  const uint8_t ksmac[16],
                                  uint64_t *send_sequence_cnt);

```

Parameters

| | |
|----------------------|---|
| file_index | <p>Parameter that specifies the file we want to read from the eMRTD. This is pointer to byte array contains exactly two bytes designating eMRTD file. Those two bytes are file identifier (FID) and there is a list of FIDs:</p> <p>EF.COM = {0x01, 0x1E} EF.DG1 = {0x01, 0x01} EF.DG2 = {0x01, 0x02} EF.DG3 = {0x01, 0x03} EF.DG4 = {0x01, 0x04} EF.DG5 = {0x01, 0x05} EF.DG6 = {0x01, 0x06} EF.DG7 = {0x01, 0x07} EF.DG8 = {0x01, 0x08} EF.DG9 = {0x01, 0x09} EF.DG10 = {0x01, 0x0A} EF.DG11 = {0x01, 0x0B} EF.DG12 = {0x01, 0x0C} EF.DG13 = {0x01, 0x0D} EF.DG14 = {0x01, 0x0E} EF.DG15 = {0x01, 0x0F} EF.DG16 = {0x01, 0x10} EF.SOD = {0x01, 0x1D}</p> |
| output | <p>After the successful call to this function, this pointer will point to the pointer on the file data read from a eMRTD file specified by the file_index parameter. Buffer, in which the data is stored, is automatically allocated during function execution. Maximum amount of data allocated can be 32KB. There is programmer responsibility to cleanup allocated data (e.g. by calling DLFree(cert) or directly free(cert) from the C/C++ code).</p> |
| output_length | <p>After the successful call to this function, this pointer is points to the size of the file data read from a eMRTD file specified by the file_index parameter.</p> |
| ksenc | <p>Session encryption key acquired using prior call to MRTDAppSelectAndAuthenticateBac() function.</p> |
| ksmac | <p>Session key for calculating MAC acquired using prior call to MRTDAppSelectAndAuthenticateBac() function.</p> |

| | |
|--------------------------|---|
| send_sequence_cnt | This pointer should point to a 64-bit value initialized by the previously successful call to MRTDAppSelectAndAuthenticateBac() function. Pointer to this 64-bit value should be saved and forwarded at every subsequent call to this function and/or other functions used for reading eMRTD. |
|--------------------------|---|

MRTDGetDGTagListFromCOM

Function description

Function declaration (C language)

```
UFR_STATUS MRTDGetDGTagListFromCOM(const uint8_t *com,
                                     uint32_t com_len,
                                     uint8_t **dg_list,
                                     uint8_t *dg_list_cnt);
```

Parameters

| | |
|--------------------|--|
| com | Pointer to the buffer containing EF.COM content. |
| com_len | Length of the EF.COM content. |
| dg_list | After the successful call to this function, this pointer will point to the pointer on the dg_list. |
| dg_list_cnt | After successful function execution, this pointer will point to the variable containing the size of the dg_list in bytes i.e. data groups count. |

MRTDValidate

Function description

This function validates data groups read from the eMRTDocument. All the elements needed for a validation are recorded in to the eMRTD and additional CSCA certificate (Country Signing Certificate Authority). During function execution, hash values of the data groups are validated. Data groups hash values have to be the same as those values embedded in the SOD file which is signed by the private key corresponding to DS certificate. DS certificate have to be included in the SOD file to. SOD content is a special case of the PKCS#7 ASN.1 DER encoded structure. Finally, DS certificate signature is validated by the external CSCA certificate which is proof of the valid certificates chain of thrust.

The countries provided their CSCA certificates on the specialized Internet sites. CSCA certificates can be in PEM (base64 encoded) or a binary files (there having extensions such as PEM, DER, CER, CRT...). Some countries have Master List files that include certificates from other countries with which they have bilateral agreements. Those Master List files have an “.ml” file extension. Additionally, the ICAO Public Key Directory (PKD) is a central repository for exchanging the information required to authenticate ePassports. For more details you can visit the [ICAO PKD web](#)

[site](#).

Function declaration (C language)

```
UFR_STATUS MRTDValidate(const char *cert_storage_folder,
                        char **out_str,
                        const char *newln,
                        uint32_t verbose_level,
                        uint8_t ksenc[16],
                        uint8_t ksmac[16],
                        uint64_t *send_sequence_cnt);
```

Parameters

| | |
|----------------------------|---|
| cert_storage_folder | Pointer to the zero terminated string which should contains path to the folder containing CSCA certificates and/or ICAO Master List files. |
| out_str | After successful function execution, this pointer will point to the pointer on the zero terminated string containing verbose printout of the validation steps. Various printout details are determined by the value of the verbose_level function parameter. |
| newln | Pointer to the zero terminated string which contains the new line escape sequence for the target system. In general case should be “\n” but on some systems can be “\r” or “\r\n”. |
| verbose_level | One of the values defined in the E_PRINT_VERBOSE_LEVELS enumeration: <pre>enum E_PRINT_VERBOSE_LEVELS { PRINT_NONE, PRINT_ESSENTIALS, PRINT_DETAILS, PRINT_ALL_PLUS_STATUSES, };</pre> |
| ksenc | Session encryption key acquired using prior call to MRTDAppSelectAndAuthenticateBac() function. |
| ksmac | Session key for calculating MAC acquired using prior call to MRTDAppSelectAndAuthenticateBac() function. |
| send_sequence_cnt | This pointer should point to a 64-bit value initialized by the previously successful call to MRTDAppSelectAndAuthenticateBac() function. Pointer to this 64-bit value should be saved and forwarded at every subsequent call to this function and/or other functions used for reading eMRTD. |

MRTDParseDG1ToHeap

Function description

Use this function to get verbose “printout” string containing MRZ (Machine Readable Zone) parsed data from the content of the EF.DG1 MRTD file. Function supports TD1, TD2 and TD3 Data Group 1 formats as defined in the ICAO Doc 9303-10 (seventh edition, 2015).

Function automatically allocates memory on the heap, which *sbuffer parameter will point to after successful execution. User is obligated to cleanup allocated memory space, occupied by the *sbuffer, after use (e.g. by calling DLFree(sbuffer) or directly free(sbuffer) from the C/C++ code).

Function declaration (C language)

```
UFR_STATUS MRTDParseDG1ToHeap(const uint8_t *dg1,
                               uint8_t dg1_len,
                               const char *newln,
                               char **sbuffer);
```

Parameters

| | |
|----------------|--|
| dg1 | Pointer to the buffer containing EF.DG1 content. |
| dg1_len | Length of the EF.DG1 content. |
| newln | Pointer to the zero terminated string which contains the new line escape sequence for the target system. In general case should be “\n” but on some systems can be “\r” or “\r\n”. |
| sbuffer | After successful function execution, this pointer will point to the pointer on the zero terminated string containing verbose printout of the parsed EF.DG1 data. |

MRTDGetImageFromDG2

Function description

Use this function to extract facial image from the EF.DG2 content. This function receives EF.DG2 content through *dg2 parameter, parse it and searches for facial image data. Pointer *image points to facial image data within *dg2 memory buffer, after successful function execution.

Function declaration (C language)

```
UFR_STATUS MRTDGetImageFromDG2(const uint8_t *dg2,
                                uint32_t dg2_size,
                                uint8_t **image,
                                uint32_t *image_size,
                                uint32_t *img_type);
```

Parameters

| | |
|-------------------|--|
| dg2 | Pointer to the buffer containing EF.DG2 content. |
| dg2_size | Length of the EF.DG2 content. |
| image | After successful function execution, this pointer will point to the pointer on the image data which is physically located in the dg2 buffer. |
| image_size | After successful function execution, variable on which this pointer points to, will contain image data length. |
| img_type | <p>After successful function execution, variable on which this pointer points to, will contain image type. Image type can be one of the values defined in the E_MRTD_IMG_TYPE enumeration:</p> <pre>enum E_MRTD_IMG_TYPE { MRTD_IMG_JPEG = 0, MRTD_IMG_JP2 = 1, MRTD_IMG_JPEG2000 = 1, // Alias for the MRTD_IMG_JP2 MRTD_IMG_TYPE_UNKNOWN = 0xFFFFFFFF };</pre> |

MRTDGetImageFromDG2ToFile**Function description**

Use this function to extract facial image from the EF.DG2 content and save it to file on the file system. This function receives EF.DG2 content through ***dg2** parameter, parse it and searches for facial image data. After successful function execution, file with path and name specified with an **file_name_without_extension** parameter is saved. File extension is determined automatically accordingly to the image type.

Function declaration (C language)

```

UFR_STATUS MRTDGetImageFromDG2ToFile(
                                const uint8_t *dg2,
                                uint32_t dg2_size,
                                const char *file_name_without_extension);

```

Parameters

| | |
|------------------------------------|---|
| dg2 | Pointer to the buffer containing EF.DG2 content. |
| dg2_size | Length of the EF.DG2 content. |
| file_name_without_extension | Pointer to the zero terminated string containing file path and name without an extension which is automatically determined accordingly to the image type. |

MRTDGetDgIndex

Function description

Use this function to get an index of the data groups from EF.DG1 to DG16 i.e. 1 to 16. For EF.COM, EF.SOD and invalid tag function returns 0.

Function declaration (C language)

```
uint32_t MRTDGetDgIndex(uint8_t dg_tag);
```

Parameters

| | |
|---------------|---|
| dg_tag | Data Group tag: <ul style="list-style-type: none"> • tag of the EF.COM is 0x60 • tag of the EF.DG1 is 0x61 • tag of the EF.DG2 is 0x75 • tag of the EF.DG3 is 0x63 • tag of the EF.DG4 is 0x76 • tag of the EF.DG5 is 0x65 • tag of the EF.DG6 is 0x66 • tag of the EF.DG7 is 0x67 • tag of the EF.DG8 is 0x68 • tag of the EF.DG9 is 0x69 • tag of the EF.DG10 is 0x6a • tag of the EF.DG11 is 0x6b • tag of the EF.DG12 is 0x6c • tag of the EF.DG13 is 0x6d • tag of the EF.DG14 is 0x6e • tag of the EF.DG15 is 0x6f • tag of the EF.DG16 is 0x70 • tag of the EF.SOD is 0x77 |
|---------------|---|

MRTDGetDgName

Function description

Use this function to get a name of the data group. Function returns pointer to the zero terminated string ("EF.COM", "EF.DG1", "EF.DG2", ... , "EF.SOD"). For invalid tag function returns zero terminated string "NOT DEFINED".

Function declaration (C language)

```
c_string MRTDGetDgName(uint8_t dg_tag);
```

Parameters

| | |
|--------|---|
| dg_tag | Data Group tag: <ul style="list-style-type: none"> • tag of the EF.COM is 0x60 • tag of the EF.DG1 is 0x61 • tag of the EF.DG2 is 0x75 • tag of the EF.DG3 is 0x63 • tag of the EF.DG4 is 0x76 • tag of the EF.DG5 is 0x65 • tag of the EF.DG6 is 0x66 • tag of the EF.DG7 is 0x67 • tag of the EF.DG8 is 0x68 • tag of the EF.DG9 is 0x69 • tag of the EF.DG10 is 0x6a • tag of the EF.DG11 is 0x6b • tag of the EF.DG12 is 0x6c • tag of the EF.DG13 is 0x6d • tag of the EF.DG14 is 0x6e • tag of the EF.DG15 is 0x6f • tag of the EF.DG16 is 0x70 • tag of the EF.SOD is 0x77 |
|--------|---|

BASE HD UFR SUPPORT FUNCTIONS

UfrXrcLockOn

Function description

Electric strike switches when the function called. Pulse duration determined by function.

Function declaration (C language)

```
UFR_STATUS UfrXrcLockOn(uint8_t pulse_duration);
```

Parameter

| | |
|----------------|---|
| pulse_duration | pulse_duration is strike switch on period in ms |
|----------------|---|

UfrXrcRelayState

Function description

Function switches relay.

Function declaration (C language)

```
UFR_STATUS UfrXrcRelayState(uint8_t state);
```

Parameter

| | |
|--------------|---|
| state | if the state is 1, then relay is switch on, and if state is 0, then relay is switch off |
|--------------|---|

UfrXrcGetIoState

Function description

Function returns states of 3 IO pins.

Function declaration (C language)

```
UFR_STATUS UfrXrcGetIoState(uint8_t *intercom,
                             uint8_t *door,
                             uint8_t *relay_state);
```

Parameters

| | |
|--------------------|--|
| intercom | shows that there is voltage at the terminals for intercom connection, or not |
| door | shows that the door's magnetic switch opened or closed |
| relay_state | is 1 if relay switch on, and 0 if relay switch off |

FUNCTIONS FOR RF ANALOG REGISTERS SETTING

These functions allow you to adjust the value of several registers on PN512. These are registers: RFCfgReg, RxThresholdReg, GsNOnReg, GsNOffReg, CWGsPReg, ModGsPReg. This can be useful if you want to increase the operation distance of card, or when it is necessary to reduce the impact of environmental disturbances.

SetRfAnalogRegistersTypeA

SetRfAnalogRegistersTypeB

SetRfAnalogRegistersISO14443_212

SetRfAnalogRegistersISO14443_424

Function description

Functions allow adjusting values of registers RFCfgReg and RxThresholdReg. Registry setting is applied to the appropriate type of communication with tag. There are ISO14443 Type A, ISO14443 TypeB, and ISO14443-4 on higher communication speeds (211 and 424 Kbps).

Functions declaration (C language):

```
UFR_STATUS SetRfAnalogRegistersTypeA(uint8_t ThresholdMinLevel,
                                     uint8_t ThresholdCollLevel,
                                     uint8_t RFLevelAmp,
                                     uint8_t RxGain,
                                     uint8_t RFLevel);
```

```
UFR_STATUS SetRfAnalogRegistersTypeB(uint8_t ThresholdMinLevel,
                                     uint8_t ThresholdCollLevel,
                                     uint8_t RFLevelAmp,
                                     uint8_t RxGain,
                                     uint8_t RFLevel);
```

```
UFR_STATUS SetRfAnalogRegistersISO14443_212(
    uint8_t ThresholdMinLevel,
    uint8_t ThresholdCollLevel,
    uint8_t RFLevelAmp,
    uint8_t RxGain,
    uint8_t RFLevel);
```

```
UFR_STATUS SetRfAnalogRegistersISO14443_424(
    uint8_t ThresholdMinLevel,
    uint8_t ThresholdCollLevel,
    uint8_t RFLevelAmp,
    uint8_t RxGain,
    uint8_t RFLevel);
```

Parameters

| | |
|---------------------------|---|
| ThresholdMinLevel | value in range 0 - 15, part of RxThresholdReg |
| ThresholdCollLevel | value in range 0 - 7, part of RxThresholdReg |
| RFLevelAmp | 0 or 1, part of RFCfgReg |
| RxGain | value in range 0 - 7, part of RFCfgReg |
| RFLevel | value in range 0 - 15, part of RFCfgReg |

SetRfAnalogRegistersTypeADefault

SetRfAnalogRegistersTypeBDefault

SetRfAnalogRegistersISO14443_212Default

SetRfAnalogRegistersISO14443_424Default

Function description

The functions set the factory default settings of the registers RFCfgReg and RxThresholdReg.

Functions declaration (C language):

```
UFR_STATUS SetRfAnalogRegistersTypeADefault(void) ;
```

```
UFR_STATUS SetRfAnalogRegistersTypeBDefault(void) ;
```

```
UFR_STATUS SetRfAnalogRegistersISO14443_212Default(void) ;
```

```
UFR_STATUS SetRfAnalogRegistersISO14443_424Default(void) ;
```

GetRfAnalogRegistersTypeA

GetRfAnalogRegistersTypeB

GetRfAnalogRegistersISO14443_212

GetRfAnalogRegistersISO14443_424

Function description

The functions read the value of the registers RFCfgReg and RxThresholdReg.

Functions declaration (C language):

```

UFR_STATUS GetRfAnalogRegistersTypeA(uint8_t *ThresholdMinLevel,
uint8_t *ThresholdCollLevel,
                                uint8_t *RFLevelAmp,
                                uint8_t *RxGain,
                                uint8_t *RFLevel);

UFR_STATUS GetRfAnalogRegistersTypeB(uint8_t *ThresholdMinLevel,
                                uint8_t *ThresholdCollLevel,
                                uint8_t *RFLevelAmp,
                                uint8_t *RxGain,
                                uint8_t *RFLevel);

UFR_STATUS GetRfAnalogRegistersISO14443_212(
                                uint8_t *ThresholdMinLevel,
                                uint8_t *ThresholdCollLevel,
                                uint8_t *RFLevelAmp,
                                uint8_t *RxGain,
                                uint8_t *RFLevel);

UFR_STATUS GetRfAnalogRegistersISO14443_424(
                                uint8_t *ThresholdMinLevel,
                                uint8_t *ThresholdCollLevel,
                                uint8_t *RFLevelAmp,
                                uint8_t *RxGain,
                                uint8_t *RFLevel);

```

Parameters

| | |
|---------------------------|---|
| ThresholdMinLevel | value in range 0 - 15, part of RxThresholdReg |
| ThresholdCollLevel | value in range 0 - 7, part of RxThresholdReg |
| RFLevelAmp | 0 or 1, part of RFCfgReg |
| RxGain | value in range 0 - 7, part of RFCfgReg |
| RFLevel | value in range 0 - 15, part of RFCfgReg |

SetRfAnalogRegistersTypeATrans***SetRfAnalogRegistersTypeBTrans*****Function description**

Functions allow adjusting values of registers RFCfgReg, RxThresholdReg, GsNOnReg, GsNOffReg, CWGsPReg, ModGsPReg. Registry setting is applied to the appropriate type of

communication with tag. There are ISO14443 Type A, ISO14443 TypeB, and ISO14443-4 on higher communication speeds (211 and 424 Kbps).

Functions declaration (C language):

```

UFR_STATUS SetRfAnalogRegistersTypeATrans (
    uint8_t ThresholdMinLevel,
    uint8_t ThresholdCollLevel,
    uint8_t RFLevelAmp,
    uint8_t RxGain,
    uint8_t RFLevel,
    uint8_t CWGsNOn,
    uint8_t ModGsNOn,
    uint8_t CWGsP,
    uint8_t CWGsNOff,
    uint8_t ModGsNOff);

UFR_STATUS SetRfAnalogRegistersTypeBTrans (
    uint8_t ThresholdMinLevel,
    uint8_t ThresholdCollLevel,
    uint8_t RFLevelAmp,
    uint8_t RxGain,
    uint8_t RFLevel,
    uint8_t CWGsNOn,
    uint8_t ModGsNOn,
    uint8_t CWGsP,
    uint8_t ModGsP);

```

Parameters

| | |
|---------------------------|---|
| ThresholdMinLevel | value in range 0 - 15, part of RxThresholdReg |
| ThresholdCollLevel | value in range 0 - 7, part of RxThresholdReg |
| RFLevelAmp | 0 or 1, part of RFCfgReg |
| RxGain | value in range 0 - 7, part of RFCfgReg |
| RFLevel | value in range 0 - 15, part of RFCfgReg |
| CWGsnOn | value in range 0 - 15, part of GsNOnReg |
| ModGsNOn | value in range 0 - 15, part of GsNOnReg |
| CWGsp | value of CWGsPReg (0 - 47) |
| CWGsnOff | value in range 0 - 15, part of GsNOffReg |
| ModGsNOff | value in range 0 - 15, part of GsNOffReg |
| ModGsP | value of ModGsPReg (0 - 47) |

GetRfAnalogRegistersTypeATrans

GetRfAnalogRegistersTypeBTrans

Function description

The functions read the value of the registers RFCfgReg, RxThresholdReg, GsNOnReg, GsNOffReg, CWGsPReg, ModGsPReg.

Functions declaration (C language):

```

UFR_STATUS GetRfAnalogRegistersTypeATrans (
    uint8_t *ThresholdMinLevel,
    uint8_t *ThresholdCollLevel,
    uint8_t *RFLevelAmp,
    uint8_t *RxGain,
    uint8_t *RFLevel,
    uint8_t *CWGsNOn,
    uint8_t *ModGsNOn,
    uint8_t *CWGsP,
    uint8_t *CWGsNOff,
    uint8_t *ModGsNOff);

UFR_STATUS GetRfAnalogRegistersTypeBTrans (
    uint8_t *ThresholdMinLevel,
    uint8_t *ThresholdCollLevel,
    uint8_t *RFLevelAmp,
    uint8_t *RxGain,
    uint8_t *RFLevel,
    uint8_t *CWGsNOn,
    uint8_t *ModGsNOn,
    uint8_t *CWGsP,
    uint8_t *ModGsP);

```

Parameters

| | |
|---------------------------|---|
| ThresholdMinLevel | value in range 0 - 15, part of RxThresholdReg |
| ThresholdCollLevel | value in range 0 - 7, part of RxThresholdReg |
| RFLevelAmp | 0 or 1, part of RFCfgReg |
| RxGain | value in range 0 - 7, part of RFCfgReg |
| RFLevel | value in range 0 - 15, part of RFCfgReg |
| CWGsnOn | value in range 0 - 15, part of GsNOnReg |
| ModGsNOn | value in range 0 - 15, part of GsNOnReg |
| CWGsp | value of CWGsPReg (0 - 47) |
| CWGsnOff | value in range 0 - 15, part of GsNOffReg |
| ModGsNOff | value in range 0 - 15, part of GsNOffReg |
| ModGsp | value of ModGsPReg (0 - 47) |

FUNCTIONS FOR DEVICE SIGNALIZATION SETTINGS

GreenLedBlinkingTurnOn

Function description

The function allows the blinking of the green diode independently of the user's signaling command (default setting).

Function declaration (C language)

```
UFR_STATUS GreenLedBlinkingTurnOn(void) ;
```

GreenLedBlinkingTurnOff

Function description

The function prohibits the blinking of the green diode independently of the user's signaling command. LED and sound signaling occurs only on the user command.

Function declaration (C language)

```
UFR_STATUS GreenLedBlinkingTurnOff(void);
```

UfrRgbLightControl**Function description**

For classic uFR PLUS devices only.

The function prohibits the blinking of the green diode (if this option set), and sets color on RGB diodes. This color stays on diodes until this function set parameter "enable" to 0.

Function declaration (C language)

```
UFR_STATUS UfrRgbLightControl(uint8_t red,
                               uint8_t green,
                               uint8_t blue,
                               uint8_t intensity,
                               uint8_t enable);
```

Parameters

| | |
|-----------|---|
| red | value of red color (0 - 255) |
| green | value of green color (0 - 255) |
| blue | value of blue color (0 - 255) |
| intensity | value of color intensity in percent (0 - 100) |
| enable | 1 - enable 0 - disable |

FUNCTIONS FOR DISPLAY CONTROL***SetDisplayData*****Function description**

This feature working with LED RING 24 display module. Function enables sending data to the display. A string of data contains information about the intensity of color in each cell of the display. Each cell has three LED (red, green and blue). For each cell of the three bytes is necessary. The first byte indicates the intensity of the green color, the second byte indicates the intensity of the red color, and the third byte indicates the intensity of blue color. For example, if the display has 16 cells, an array contains 48 bytes. Value of intensity is in range from 0 to 255.

Function declaration (C language)

```
UFR_STATUS SetDisplayData(uint8_t *display_data,
                          uint8_t data_length);
```

Parameters

| | |
|---------------------|---------------------------|
| display_data | pointer to data array |
| data_length | number of data into array |

SetDisplayIntensity**Function description**

Function sets the intensity of light on the display. Value of intensity is in range 0 to 100.

Function declaration (C language)

```
UFR_STATUS SetDisplayIntensity(uint8_t intensity);
```

Parameter

| | |
|------------------|------------------------------|
| intensity | value of intensity (0 – 100) |
|------------------|------------------------------|

GetDisplayIntensity**Function description**

Function gets the intensity of light on the display.

Function declaration (C language)

```
UFR_STATUS GetDisplayIntensity(uint8_t *intensity);
```

Parameter

| | |
|------------------|----------------------|
| intensity | pointer to intensity |
|------------------|----------------------|

Functions for transceiver mode

For uFR PLUS devices only

In this mode, the data is entered via the serial port transmitted through the RF field to the card, and the card response is transmitted to the serial port.

card_transceiver_mode_start**Function description**

Function sets the parameters for transceiver mode. If the hardware CRC option is used, then only command bytes sent to card (hardware will add two bytes of CRC to the end of RF packet). If this

option did not use, then command bytes and two bytes of CRC sent to card (i.e. ISO14443 typeA CRC). Timeout for card response in us sets.

Card is selected and waiting for commands.

Function declaration (C language)

```
UFR_STATUS card_transceive_mode_start(uint8_t tx_crc,
                                       uint8_t rx_crc,
                                       uint32_t rf_timeout,
                                       uint32_t uart_timeout);
```

Parameters

| | |
|---------------------|--|
| tx_crc | hardware RF TX crc using (1 - yes, 0 - no) |
| rx_crc | hardware RF RX crc using (1 - yes, 0 - no) |
| rf_timeout | timeout for card response in us |
| uart_timeout | timeout for UART response in ms |

card_transceive_mode_stop

Function description

The function returns the reader to normal mode.

Function declaration (C language)

```
UFR_STATUS DL_API card_transceive_mode_stop(void);
```

uart_transceive

Function description

The function sends data through the serial port to the card.

Function declaration (C language)

```
UFR_STATUS DL_API uart_transceive(uint8_t *send_data,
                                   uint8_t send_len,
                                   uint8_t *rcv_data,
                                   uint32_t bytes_to_receive,
                                   uint32_t *rcv_len);
```

Parameters

| | |
|-------------------------|---|
| send_data | pointer to data array for sending to card |
| send_len | number of bytes for sending |
| rcv_data | pointer to data array received from card |
| bytes_to_receive | expected number of bytes received from card |
| rcv_len | number of bytes received from card |

Functions for Mifare Ultralight C card

For uFR PLUS devices only

ULC_ExternalAuth_PK

Function description

The 3DES authentication is executed using the transceive mode of reader. Pointer to array which contains 2K 3DES key (16 bytes) is parameter of this functions. Function don't use the key which stored into reader. DES algorithm for authentication executes in host device, not in reader.

After authentication, the reader leaves the transceive mode, but stay in mode where the HALT command doesn't sending to the card. In this mode user can use functions for block and linear reading or writing. Reader stay into this mode, until the error during reading data from card, or writing data into card occurs, or until the user calls function **card_halt_enable()**.

Function declaration (C language)

```
UFR_STATUS DL_API ULC_ExternalAuth_PK(uint8_t *key);
```

Parameter

| | |
|------------|--|
| key | pointer to data array of 16 bytes which contains 2K 3DES key |
|------------|--|

card_halt_enable

Function description

Function enables normal working mode of reader, after leaving the transceive working mode with blocking card HALT command in the main loop.

Function declaration (C language)

```
UFR_STATUS DL_API card_halt_enable(void);
```

[ULC_write_3des_key_no_auth](#)

[ULC_write_3des_key_factory_key](#)

[ULC_write_3des_key](#)

Function description

3DES key is stored into card in pages 44 - 47. Byte order is described in the card datasheet. The user can write key into card by function BlockWrite for each page (44 - 47) after successful 3DES authentication if this is necessary, or by one of these functions. Authentication configuration pages are 42 and 43. The parameters of configuration is described in the card datasheet.

Factory setting of card don't require authentication for 3DES key writing into pages 44 - 47. In this case user can use function ULC_write_3des_key_no_auth, or BlockWrite for each page.

If the authentication configuration is changed to mandatory 3DES authentication for writing pages 44 - 47, and 3DES key doesn't written into card, then for authentication uses the factory 3DES key. In this case the user can use function ULC_write_3des_key_factory_key, or function ULC_ExternalAuth_PK with factory key which described in the card datasheet, and BlockWrite for each page.

If the 3DES key already written into card, and authentication for pages 44 - 47 is mandatory, then for authentication uses current 3DES key. In this case user can use function ULC_write_3des_key, or function ULC_ExternalAuth_PK with current key, and BlockWrite for each page.

Functions declaration (C language)

```
UFR_STATUS DL_API ULC_write_3des_key_no_auth
                                (uint8_t *new_3des_key);
UFR_STATUS DL_API ULC_write_3des_key_factory_key
                                (uint8_t *new_3des_key);
UFR_STATUS DL_API ULC_write_3des_key(uint8_t *new_3des_key,
                                uint8_t *old_3des_key);
```

Parameters

| | |
|---------------------|---|
| new_3des_key | pointer to array of 16 bytes which contains new 2K 3DES key |
| old_3des_key | pointer to array of 16 bytes which contains current 2K 3DES key |

Anti-collision support i.e. multi card reader mode

For uFR PLUS devices only (supported from firmware version 5.0.1 and library version 4.3.13)

After power on or resetting the reader it is in a "single card" mode of operation. In this mode reader

can only work with one card in the field and card is selected automatically.

uFR PLUS devices can be placed in so-called “anti-collision” mode of operation using `EnableAntiCollision()` function call. In that mode reader can work with multiple cards in the field. Fundamental problem in a “anti-collision” mode of operation is the amount of energy that is required to power the cards in the field. Different types of cards require more or less energy. So the maximum number of cards with which reader can work simultaneously depends on specific needs for powering different cards in the field. The reader can work with up to 4 cards that have low average consumption, at a time. Cards that have low average consumption include the following models: Mifare Ultralight, Mifare Classic, Ntag series.

All the card models which supports modern cryptography mechanisms have higher power consumption. So in the case of Mifare Desfire, Mifare Ultralight C, Mifare Plus, Java Cards and other high consumption cards there should be no more than 2 cards in the reader field at a time.

EnableAntiCollision

Function description

This function put the reader in a “anti-collision” mode of operation.

Function declaration (C language)

```
UFR_STATUS EnableAntiCollision(void) ;
```

DisableAntiCollision

Function description

Exits from “anti-collision” mode of operation i.e. put the reader in to “single card” mode of operation.

Function declaration (C language)

```
UFR_STATUS DisableAntiCollision(void) ;
```

EnumCards

Function description

If the reader is in a “anti-collision” mode of operation, this function enumerate cards which are found in the reader field. Otherwise function returns `ANTI_COLLISION_DISABLED` status code.

All the calls to the `ListCards()`, `SelectCard()` and `DeselectCard()` works with UIDs from the actual UID list of the enumerated cards, which is obtained by the last call of this function.

Function declaration (C language)

```
UFR_STATUS EnumCards(uint8_t *lpucCardsNumber,
                    uint8_t *lpucUidListSize);
```

Parameters

| | |
|-----------------|---|
| lpucCardsNumber | If the function is successfully executed, the memory location on which this pointer points to, will contain number of the enumerated cards. |
| lpucUidListSize | If the function is successfully executed, the memory location on which this pointer points to, will contain UID list of the enumerated cards size in bytes. |

ListCards

Function description

Before calling this function you have to call EnumCards() first.

For each UID, of the cards detected in the reader field, there is 11 “UID record bytes” allocated in the list. First of those 11 bytes allocated designate actual UID length immediately followed by the exactly 10 bytes of UID (which is maximum hypothetical UID size). E.g, if the actual UID length is 4 bytes, you should ignore last 6 bytes of the UID record.

Function declaration (C language)

```
UFR_STATUS ListCards(uint8_t *aucUidList,
                    uint8_t ucUidListSize);
```

Parameters

| | |
|---------------|---|
| aucUidList | Pointer to the memory allocated for the UID list. Before calling this function, you should allocate atleast *lpucUidListSize bytes which is returned by the prior call to EnumCards() function. |
| ucUidListSize | Size (in bytes) of the array allocated on the memory location aucUidList points to. |

SelectCard

Function description

Selects one of the cards which UID is on the actual UID list of the enumerated cards. If there is any of the cards previously selected calling this function you will get an CARD_ALREADY_SELECTED status code and, in such a case, you should call DeslectCard() function prior using SelectCard(). If UID list of the enumerated cards is empty, you will get an NO_TAGS_ENUMERRATED status code.

Function declaration (C language)

```
UFR_STATUS SelectCard(const uint8_t *aucUid,  
                      uint8_t ucUidSize,  
                      uint8_t *lpucSelctedCardType) ;
```

Parameters

| | |
|----------------------------|---|
| aucUid | pointer to the byte array containing UID of the card which is to be selected |
| ucUidSize | actual UID size |
| lpucSelctedCardType | pointer to byte which will contain DlogicCardType constant of the selected card, in case of successful execution of this function |

DeslectCard

Function description

If the reader is in a “anti-collision” mode of operation, this function deselects currently selected card. Otherwise function returns ANTI_COLLISION_DISABLED status code.

Function declaration (C language)

```
UFR_STATUS DeslectCard(void);
```

GetAntiCollisionStatus

Function description

Calling this function you can get current anti-collision status of the reader.

Function declaration (C language)

```
UFR_STATUS GetAntiCollisionStatus(int8_t *lpcIsAntiCollEnabled,  
                                int8_t *lpcIsAnyCardSelected);
```

Parameters

| | |
|----------------------|---|
| lpcIsAntiCollEnabled | pointer to byte which will contain 1 if reader is in a “anti-collision” mode of operation, 0 otherwise |
| lpcIsAnyCardSelected | pointer to byte which will contain 1 if reader is in a “anti-collision” mode of operation and there is selected card, 0 otherwise |

Functions for uFR Online

For uFR Online devices only.

EspReaderReset

Function

Physical reset of uFR reader communication port.

description

Function declaration (C language)

```
UFR_STATUS EspReaderReset(void)
```

No parameters required.

EspSetDisplayData

Function description

Function enables sending data to the uFR Online. A string of data contains information about the intensity of color in each cell of the LED indication. Each cell has three LED (red, green and blue). For each cell of the three bytes is necessary. The first byte indicates the intensity of the green color, the second byte indicates the intensity of the red color, and the third byte indicates the intensity of blue color. For example, if the display has 2 cells, an array contains 6 bytes. Value of intensity is in range from 0 to 255. On uFR Online, there are 2 cells.

Function declaration (C language)

```
UFR_STATUS EspSetDisplayData(uint8_t *display_data,
                             uint8_t data_length, uint16_t duration);
```

Parameters

| | |
|---------------------|----------------------------------|
| display_data | pointer to data array |
| data_length | number of data into array |
| duration | number of milliseconds to light. |

EspChangeReaderPassword

Function description

It defines/changes password which I used for:

- Writing in EEPROM
- Setting date/time of RTC

Function declaration (C language)

```
UFR_STATUS EspChangeReaderPassword(uint8_t *old_password,
                                   uint8_t *new_password)
```

Parameters

| | |
|---------------------|--|
| old_password | pointer to the 8 bytes array containing current password |
| new_password | pointer to the 8 bytes array containing new password |

EspReaderEepromWrite

Function description

Function writes array of data into EEPROM of uFR Online. Maximal length of array is 128 bytes. Function requires password which length is 8 bytes. Factory password is "11111111" (0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31).

Function declaration (C language)

```
UFR_STATUS EspReaderEepromWrite(uint8_t *data,
                                uint32_t address,
                                uint32_t size,
                                uint8_t *password);
```

Parameters

| | |
|-----------------|--------------------------------------|
| data | pointer to array containing data |
| address | address of first data |
| size | length of array |
| password | pointer to array containing password |

EspReaderEepromRead

Function description

Function returns array of data read from EEPROM of uFR Online. Maximal length of array is 128 bytes.

Function declaration (C language)

```
UFR_STATUS EspReaderEepromRead(uint8_t *data,  
                                uint32_t address,  
                                uint32_t size);
```

Parameters

| | |
|----------------|--|
| data | pointer to array containing data from EEPROM |
| address | address of first data |
| size | length of array |

EspGetReaderTime

Function description

Function returns 6 bytes array of **uint8_t** that represented current date and time into uFR Online RTC.

- Byte 0 represent year (current year – 2000)
- Byte 1 represent month (1 – 12)
- Byte 2 represent day of the month (1 – 31)
- Byte 3 represent hour (0 – 23)
- Byte 4 represent minute (0 – 59)
- Byte 5 represent second (0 – 59)

Function declaration (C language)

```
UFR_STATUS EspGetReaderTime(uint8_t *time);
```

Parameter

| | |
|-------------|--|
| time | pointer to the array containing current date and time representation |
|-------------|--|

*EspSetReaderTime***Function description**

Function sets the date and time into uFR Online RTC. Function requires the 8 bytes password entry to set date and time. Date and time are represent into 6 bytes array in same way as in EspGetReaderTime function. Factory password is "11111111" (0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31).

Function declaration (C language)

```
UFR_STATUS EspSetReaderTime(uint8_t *password,  
                             uint8_t *time);
```

Parameters

| | |
|-----------------|--|
| password | pointer to the 8 bytes array containing password |
| time | pointer to the 6 bytes array containing date and time representation |

*EspSetIOState***Function description**

Function sets uFR Online IO pin state.

Function declaration (C language)

```
UFR_STATUS EspSetReaderTime(uint8_t pin,  
                             uint8_t state);
```

Parameters

| | |
|--------------|---|
| pin | IO pin number (1 - 6) |
| state | IO pin state 0 - low level, 1 - high level, 2 - input |

*EspGetIOState***Function description**

Function returns 6 bytes array of uint8_t that represented IO pins logic level state.

Function declaration (C language)

```
UFR_STATUS EspGetReaderTime(uint8_t *state);
```

Parameters

| | |
|-------|--|
| state | pointer to the 6 bytes array containing IO pins states |
|-------|--|

*EspSetTransparentReader***Function description**

Function sets uFR Online transparent reader.

Function declaration (C language)

```
UFR_STATUS EspSetReaderTime(uint8_t reader);
```

Parameters

| | |
|--------|---------------------------|
| reader | Transparent reader number |
|--------|---------------------------|

NDEF Messages

Support for various NDEF messages is added. You can store them into reader (for tag emulation mode) or into card. Every function that write NDEF message into card has its own read function. If you try to read NDEF message with wrong function (for example, you stored Bluetooth MAC address as NDEF message and trying to read it with function that reads WiFi configuration), UFR_NDEF_MESSAGE_NOT_COMPATIBLE status is returned.

*WriteNdefRecord_WiFi***Function**

Store WiFi configuration as NDEF message into reader or into card.

description**Function declaration (C language)**

```
UFR_STATUS WriteNdefRecord_WiFi(uint8_t ndef_storage,
                                const char *ssid,
                                uint8_t auth_type,
                                uint8_t encryption_type,
                                const char *password);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| ssid | Pointer to the null-terminated string that should contain SSID name we want to connect to |
| auth_type | Authentication type: |

| | | |
|-----------------|--|--|
| | 0 1 - WPA 2 - WPA 3 - WPA2 4 - WPA2 Personal | OPEN Personal Enterprise Enterprise |
| encryption_type | Encryption type: 0 - NONE 1 - WEP 2 - TKIP 3 - AES 4 - AES/TKIP | |
| password | Pointer to the null-terminated string that should contain password of the SSID we want to connect to | |

WriteNdefRecord_Bluetooth

Function

Store Bluetooth MAC address for pairing as NDEF message into reader or into card.

description

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Bluetooth(uint8_t ndef_storage,
                                     const char *bt_mac_address);
```

Parameters

| | |
|----------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| bt_mac_address | Pointer to the null-terminated string that should contain Bluetooth MAC address for pairing in hex format (12 characters) (e.g.: "AABBCCDDEEFF") |

WriteNdefRecord_SMS

Function

Store phone number and message data as NDEF message into reader or into card.

description

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_SMS(uint8_t ndef_storage,
                                const char *phone_number,
                                const char *message);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| phone_number | Pointer to the null-terminated string that should contain phone number we want to send message to |
| message | Pointer to the null-terminated string that should contain message data |

WriteNdefRecord_Bitcoin

Function

description

Store bitcoin address, amount and donation message as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Bitcoin(uint8_t ndef_storage,
                                    const char *bitcoin_address,
                                    const char *amount,
                                    const char *message);
```

Parameters

| | |
|-----------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| bitcoin_address | Pointer to the null-terminated string that should contain bitcoin address |
| amount | Pointer to the null-terminated string that should contain amount (e.g.: "1.0") |
| message | Pointer to the null-terminated string that should contain donation message |

WriteNdefRecord_GeoLocation

Function

description

Store latitude and longitude as NDEF message into reader or into card.

Function declaration (C language)


```
UFR_STATUS WriteNdefRecord_GeoLocation(uint8_t ndef_storage,
                                         const char *latitude,
                                         const char *longitude);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| latitude | Pointer to the null-terminated string that should contain latitude (e.g.: "44.6229337") |
| longitude | Pointer to the null-terminated string that should contain longitude (e.g.: "21.1787368") |

WriteNdefRecord_NaviDestination

Function

description

Store wanted destination as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_NaviDestination(uint8_t ndef_storage,
                                             const char *destination);
```

Parameters

| | |
|--------------|--|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| destination | Pointer to the null-terminated string that should contain city, street name or some other destination |

WriteNdefRecord_Email

Function

description

Store email message as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Email(uint8_t ndef_storage,
                                   const char *email_address,
                                   const char *subject,
                                   const char *message);
```

Parameters

| | |
|--------------|---------------------------------------|
| ndef_storage | Store NDEF into: reader - 0, card - 1 |
|--------------|---------------------------------------|

| | |
|---------------|---|
| | From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| email_address | Pointer to the null-terminated string that should contain recipient email address |
| subject | Pointer to the null-terminated string that should contain subject |
| message | Pointer to the null-terminated string that should contain message |

WriteNdefRecord_Address

Function

description

Store address (city, street name, etc) as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Address(uint8_t ndef_storage,
                                   const char *address);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| address | Pointer to the null-terminated string that should contain city name, street name, etc. |

WriteNdefRecord_AndroidApp

Function

description

Store android app package name as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_AndroidApp(uint8_t ndef_storage,
                                       const char *package_name);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| package_name | Pointer to the null-terminated string that should contain android app package name |

WriteNdefRecord_Text

Function

description

Store text as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Text(uint8_t ndef_storage,
                                const char *text);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| text | Pointer to the null-terminated string that should contain text |

WriteNdefRecord_StreetView

Function

description

Store latitude and longitude as NDEF message into reader or into card for Google StreetView.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_StreetView(uint8_t ndef_storage,
                                       const char *latitude,
                                       const char *longitude);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| latitude | Pointer to the null-terminated string that should contain latitude (e.g.: "44.6229337") |
| longitude | Pointer to the null-terminated string that should contain longitude (e.g.: "21.1787368") |

WriteNdefRecord_Skype

Function

description

Store skype username as NDEF message into reader or into card for call or chat.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Skype(uint8_t ndef_storage,
                                   const char *user_name,
                                   uint8_t action);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| user_name | Pointer to the null-terminated string that should contain skype username |
| action | Action type: call - 0 chat - 1 |

WriteNdefRecord_Whatsapp

Function

description

Store Whatsapp message as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Whatsapp(uint8_t ndef_storage,
                                       const char *message);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| message | Pointer to the null-terminated string that should contain Whatsapp message |

WriteNdefRecord_Viber

Function

description

Store Viber message as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Viber(uint8_t ndef_storage,
                                    const char *message);
```

Parameters

| | |
|--------------|---------------------------------------|
| ndef_storage | Store NDEF into: reader - 0, card - 1 |
|--------------|---------------------------------------|

| | |
|---------|---|
| | From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| message | Pointer to the null-terminated string that should contain Viber message |

WriteNdefRecord_Contact

Function

Store phone contact as NDEF message into reader or into card.

description

Function declaration (C language)

```

UFR_STATUS WriteNdefRecord_Contact(uint8_t ndef_storage,
                                     const char *name,
                                     const char *company,
                                     const char *address,
                                     const char *phone,
                                     const char *email,
                                     const char *website);

```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| name | Pointer to the null-terminated string that should contain contact display name |
| company | Pointer to the null-terminated string that should contain contact company name |
| address | Pointer to the null-terminated string that should contain contact residential address |
| phone | Pointer to the null-terminated string that should contain contact phone number |
| email | Pointer to the null-terminated string that should contain contact email address |
| website | Pointer to the null-terminated string that should contain contact website |

WriteNdefRecord_Phone

Function

Store phone_number as NDEF message into reader or into card.

description

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Phone(uint8_t ndef_storage,
                                   const char *phone_number);
```

Parameters

| | |
|--------------|---|
| ndef_storage | Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM |
| phone_number | Pointer to the null-terminated string that should contain phone_number |

ReadNdefRecord_WiFi

Function

Reads NDEF WiFi configuration from card..

description

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_WiFi(char *ssid,
                                char *auth_type,
                                char *encryption_type,
                                char *password);
```

Parameters

| | |
|-----------------|--|
| ssid | Pointer to char array containing SSID name |
| auth_type | Pointer to char array containing authentication type |
| encryption_type | Pointer to char array containing encryption type |
| password | Pointer to char array containing password |

ReadNdefRecord_Bluetooth

Function**description**

Reads NDEF Bluetooth MAC address for pairing from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Bluetooth(char *bt_mac_address) ;
```

Parameters

| | |
|----------------|--|
| bt_mac_address | Pointer to char array containing Bluetooth MAC address |
|----------------|--|

ReadNdefRecord_SMS

Function**description**

Reads NDEF phone number and message from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_SMS(char *phone_number,  
                               char *message) ;
```

Parameters

| | |
|--------------|---|
| phone_number | Pointer to char array containing phone number |
| message | Pointer to char array containing message |

ReadNdefRecord_Bitcoin

Function**description**

Reads NDEF bitcoin address, amount and donation message from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Bitcoin(char *bitocin_address,  
                                   char *amount,  
                                   char *message) ;
```

Parameters

| | |
|-----------------|--|
| bitcoin_address | Pointer to char array containing bitcoin_address |
| amount | Pointer to char array containing bitcoin amount |

| | |
|---------|---|
| message | Pointer to char array containing donation message |
|---------|---|

ReadNdefRecord_GeoLocation

Function

Reads NDEF latitude and longitude from card.

description

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_GeoLocation(char *latitude,
                                         char *longitude);
```

Parameters

| | |
|-----------|--|
| latitude | Pointer to char array containing latitude |
| longitude | Pointer to char array containing longitude |

ReadNdefRecord_NaviDestination

Function

Reads NDEF navigation destination from card.

description

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_NaviDestination(char *destination);
```

Parameters

| | |
|-------------|--|
| destination | Pointer to char array containing destination |
|-------------|--|

ReadNdefRecord_Email

Function

Reads NDEF email address, subject and message from card.

description**Function declaration (C language)**

```
UFR_STATUS ReadNdefRecord_Email(char *email_address,
                                char *subject,
                                char *message) ;
```

Parameters

| | |
|---------------|--|
| email_address | Pointer to char array containing recipient email address |
| subject | Pointer to char array containing subject |
| message | Pointer to char array containing message |

ReadNdefRecord_Address

Function

Reads NDEF address (city, street name,etc) from card.

description**Function declaration (C language)**

```
UFR_STATUS ReadNdefRecord_Address(char *address) ;
```

Parameters

| | |
|---------|--|
| address | Pointer to char array containing address |
|---------|--|

ReadNdefRecord_Text

Function

Reads NDEF text from card.

description**Function declaration (C language)**

```
UFR_STATUS ReadNdefRecord_Text(char *text) ;
```

Parameters

| | |
|------|---------------------------------------|
| text | Pointer to char array containing text |
|------|---------------------------------------|

ReadNdefRecord_StreetView

Function**description**

Reads NDEF latitude and longitude for Google StreetView from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_StreetView(char *latitude,  
                                       char *longitude);
```

Parameters

| | |
|-----------|--|
| latitude | Pointer to char array containing latitude |
| longitude | Pointer to char array containing longitude |

ReadNdefRecord_Skype

Function**description**

Reads NDEF skype username and action from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Skype(char *user_name,  
                                 char *action);
```

Parameters

| | |
|-----------|--|
| user_name | Pointer to char array containing Skype username |
| action | Pointer to char array containing Skype action ("call" or "chat") |

ReadNdefRecord_Whatsapp

Function**description**

Reads NDEF Whatsapp message from card.

Function declaration (C language)**UFR_STATUS** ReadNdefRecord_Whatsapp(**char** *message) ;**Parameters**

| | |
|---------|---|
| message | Pointer to char array containing Whatsapp message |
|---------|---|

ReadNdefRecord_Viber

Function**description**

Reads NDEF Viber message from card.

Function declaration (C language)**UFR_STATUS** ReadNdefRecord_Viber(**char** *message) ;**Parameters**

| | |
|---------|--|
| message | Pointer to char array containing Viber message |
|---------|--|

ReadNdefRecord_Contact

Function**description**

Reads NDEF phone contact from card.

Function declaration (C language)**UFR_STATUS** ReadNdefRecord_Contact(**char** *vCard) ;**Parameters**

| | |
|-------|---|
| vCard | Pointer to char array containing phone contact data |
|-------|---|

ReadNdefRecord_Phone

Function

Reads NDEF phone number from card.

description

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Phone(char *phone_number);
```

Parameters

| | |
|--------------|---|
| phone_number | Pointer to char array containing phone number |
|--------------|---|

NT4H cards functions

From library version 5.0.29. and firmware version 5.0.32

Supported cards are NT4H1321 (NTAG 413 DNA) and NT4H2421Gx (NTAG 424 DNA) card.

NTAG 424 DNA is fully compliant with the NFC Forum Type 4 Tag IC specification (Certification ID: 58562), with the contactless proximity protocol according to ISO/IEC14443-4 and the ISO/IEC 7816-4 based file system and command frames.

nt4h_set_global_parameters

Function description

Function sets file number, key number, and communication mode, before the using functions for reading and writing data into card which are used for NTAG 2xx cards. This makes it possible to use existing functions for the block and linear reading and writing.

Function declaration (C language)

```
UFR_STATUS nt4h_set_global_parameters(uint8_t file_no,
                                      uint8_t key_no,
                                      uint8_t communication_mode);
```

Parameters

| | |
|--------------------|--|
| file_no | NTAG 413 - 1 or 2 NTAG 424 - 1 to 3 |
| key_no | NTAG 413 - 0 to 2 NTAG 424 - 0 to 4 |
| communication_mode | 0 - plain, 1 - macked, 3 - enciphered |

[*nt4h_change_standard_file_settings*](#)

[*nt4h_change_standard_file_settings_pk*](#)

Function description

The function changes the access parameters of an existing standard data file. The communication mode can be either plain or enciphered based on current access right of the file, so current communication mode must be entered. Access rights are similar like for Desfire card.

Function declaration (C language)

```

UFR_STATUS nt4h_change_standard_file_settings_pk(
    IN uint8_t *aes_key_ext,
    uint8_t file_no,
    uint8_t key_no,
    uint8_t curr_communication_mode,
    uint8_t new_communication_mode,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no);
UFR_STATUS DL_API nt4h_change_standard_file_settings(
    uint8_t aes_key_no,
    uint8_t file_no,
    uint8_t key_no,
    uint8_t curr_communication_mode,
    uint8_t new_communication_mode,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no);

```

Parameters

| | |
|--------------------------------|---|
| *aes_key_ext | pointer to array contained AES key |
| aes_key_no | ordinal number of AES key into reader (0 - 15) |
| file_no | NTAG 413 - 1 or 2 NTAG 424 - 1 to 3 |
| key_no | current change key number NTAG 413 - 0 to 2 NTAG 424 - 0 to 4 |
| curr_communication_mode | current communication mode 0 - plain, 1 - macked, 3 - enciphered |
| new_communication_mode | new communication mode 0 - plain, 1 - macked, 3 - enciphered |
| read_key_no | reading key number |
| write_key_no | writing key number |
| read_write_key_no | reading and writing key number |
| change_key_no | new change key number |

[*nt4h_change_sdm_file_settings*](#)

[*nt4h_change_sdm_file_settings_pk*](#)

Function description

Function allows change parameters for secure dynamic messaging file, or change file type from standard data file to secure dynamic messaging file. Due to the large number of parameters, the function is separated from the function for creating a standard data file.

Function declaration (C language)


```

UFR_STATUS nt4h_change_sdm_file_settings_pk(
    IN uint8_t *aes_key_ext,
    uint8_t file_no,
    uint8_t key_no,
    uint8_t curr_communication_mode,
    uint8_t new_communication_mode,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t uid_enable,
    uint8_t read_ctr_enable,
    uint8_t read_ctr_limit_enable,
    uint8_t enc_file_data_enable,
    uint8_t meta_data_key_no,
    uint8_t file_data_read_key_no,
    uint8_t read_ctr_key_no,
    uint32_t uid_offset,
    uint32_t read_ctr_offset,
    uint32_t picc_data_offset,
    uint32_t mac_input_offset,
    uint32_t enc_offset,
    uint32_t enc_length,
    uint32_t mac_offset,
    uint32_t read_ctr_limit);

UFR_STATUS nt4h_change_sdm_file_settings(
    uint8_t aes_key_no,
    uint8_t file_no,
    uint8_t key_no,
    uint8_t curr_communication_mode,
    uint8_t new_communication_mode,
    uint8_t read_key_no,
    uint8_t write_key_no,
    uint8_t read_write_key_no,
    uint8_t change_key_no,
    uint8_t uid_enable,
    uint8_t read_ctr_enable,
    uint8_t read_ctr_limit_enable,
    uint8_t enc_file_data_enable,
    uint8_t meta_data_key_no,
    uint8_t file_data_read_key_no,
    uint8_t read_ctr_key_no,
    uint32_t uid_offset,
    uint32_t read_ctr_offset,
    uint32_t picc_data_offset,
    uint32_t mac_input_offset,
    uint32_t enc_offset,
    uint32_t enc_length,
    uint32_t mac_offset,
    uint32_t read_ctr_limit);

```

Parameters

| | |
|--------------------------------|--|
| *aes_key_ext | pointer to array contained AES key |
| aes_key_no | ordinal number of AES key into reader (0 - 15) |
| file_no | NTAG 413 - 1 or 2 NTAG 424 - 1 to 3 |
| key_no | current change key number NTAG 413 - 0 to 2 NTAG 424 - 0 to 4 |
| curr_communication_mode | current communication mode 0 - plain, 1 - macked, 3 - enciphered |
| new_communication_mode | new communication mode 0 - plain |
| read_key_no | reading key number (14 free access) |
| write_key_no | writing key number |
| read_write_key_no | reading and writing key number |
| change_key_no | new change key number |
| uid_enable | UID mirroring (0 - disabled, 1 - enabled) |
| read_ctr_enable | SDM reading counter (0 - disabled, 1 - enabled) |
| read_ctr_limit_enable | SDM reading counter limit (0 - disabled, 1 - enabled) |
| enc_file_data_enable | using encrypted part of file data (NTAG 424 only) (0 - disabled, 1 - enabled) |
| meta_data_key_no | key number for PICC data (UID and SDM read ctr) encryption 0 - 4 (NTAG 424 only), 14 no encryption, 15 no PICC data |
| file_data_read_key_no | key number for MAC and encrypted part of file data (NTAG 424 only) 0 - 2 or 0 - 4, 15 no MAC |
| read_ctr_key_no | key number for SDM reading counter retrieving 0 - 2 or 0 - 4, 14 free, 15 no access |
| uid_offset | mirror position of UID if PICC data aren't encrypted |
| read_ctr_offset | mirror position of SDM reading counter if PICC data aren't encrypted |
| picc_data_offset | mirror position of encrypted PICC data (NTAG 424 only) |
| mac_input_offset | offset in the file where the SDM MAC computation starts |
| enc_offset | mirror position of encrypted part of file data (NTAG 424 only) |
| enc_length | length of encrypted part of file data (NTAG 424 only) |

| | |
|-----------------------|------------------------------------|
| mac_offset | mirror position of SDM MAC |
| read_crt_limit | value of SDM reading counter limit |

nt4h_get_file_settings

Function description

Function returns file settings.

Function declaration (C language)

```
UFR_STATUS nt4h_get_file_settings(uint8_t file_no,  
                                   VAR uint8_t *file_type,  
                                   VAR uint8_t *communication_mode,  
                                   VAR uint8_t *sdm_enable,  
                                   VAR uint32_t *file_size,  
                                   VAR uint8_t *read_key_no,  
                                   VAR uint8_t *write_key_no,  
                                   VAR uint8_t *read_write_key_no,  
                                   VAR uint8_t *change_key_no,  
                                   VAR uint8_t *uid_enable,  
                                   VAR uint8_t *read_ctr_enable,  
                                   VAR uint8_t *read_ctr_limit_enable,  
                                   VAR uint8_t *enc_file_data_enable,  
                                   VAR uint8_t *meta_data_key_no,  
                                   VAR uint8_t *file_data_read_key_no,  
                                   VAR uint8_t *read_ctr_key_no,  
                                   VAR uint32_t *uid_offset,  
                                   VAR uint32_t *read_ctr_offset,  
                                   VAR uint32_t *picc_data_offset,  
                                   VAR uint32_t *mac_input_offset,  
                                   VAR uint32_t *enc_offset,  
                                   VAR uint32_t *enc_length,  
                                   VAR uint32_t *mac_offset,  
                                   VAR uint32_t *read_ctr_limit);
```

Parameters

| | |
|-------------------------------|--|
| file_no | NTAG 413 - 1 or 2 NTAG 424 - 1 to 3 |
| *file_type | 0 - standard data file |
| *communication_mode | communication mode 0 - plain, 1 - macked, 3 - enciphered |
| *sdm_enable | 0 - SDM disabled, 1 - SDM enabled |
| *read_key_no | reading key number |
| *write_key_no | writing key number |
| *read_write_key_no | reading and writing key number |
| *change_key_no | new change key number |
| *uid_enable | UID mirroring (0 - disabled, 1 - enabled) |
| *read_ctr_enable | SDM reading counter (0 - disabled, 1 - enabled) |
| *read_ctr_limit_enable | SDM reading counter limit (0 - disabled, 1 - enabled) |
| *enc_file_data_enable | using encrypted part of file data (NTAG 424 only) (0 - disabled, 1 - enabled) |
| *meta_data_key_no | key number for PICC data (UID and SDM read ctr) encryption 0 - 4 (NTAG 424 only), 14 no encryption, 15 no PICC data |
| *file_data_read_key_no | key number for MAC and encrypted part of file data (NTAG 424 only) 0 - 2 or 0 - 4, 15 no MAC |
| *read_ctr_key_no | key number for SDM reading counter retrieving 0 - 2 or 0 - 4, 14 free, 15 no access |
| *uid_offset | mirror position of UID if PICC data aren't encrypted |
| *read_ctr_offset | mirror position of SDM reading counter if PICC data aren't encrypted |
| *picc_data_offset | mirror position of encrypted PICC data (NTAG 424 only) |
| *mac_input_offset | offset in the file where the SDM MAC computation starts |
| *enc_offset | mirror position of encrypted part of file data (NTAG 424 only) |
| *enc_length | length of encrypted part of file data (NTAG 424 only) |
| *mac_offset | mirror position of SDM MAC |
| *read_crt_limit | value of SDM reading counter limit |

[*nt4h_set_rid*](#) [*nt4h_set_rid_pk*](#)

Function description

Function enables card Random ID.

Function declaration (C language)

```
UFR_STATUS nt4h_set_rid_pk(IN uint8_t *aes_key_ext);
UFR_STATUS nt4h_set_rid(uint8_t aes_key_no);
```

Parameters

| | |
|---------------------|--|
| *aes_key_ext | pointer to array contained AES key |
| aes_key_no | ordinal number of AES key into reader (0 - 15) |

[*nt4h_get_uid*](#) [*nt4h_get_uid_pk*](#)

Function description

Function returns card UID if Random ID activated. Valid authentication is required.

Function declaration (C language)

```
UFR_STATUS nt4h_get_uid(uint8_t auth_key_no,
                        uint8_t key_no,
                        OUT uint8_t *uid);
UFR_STATUS nt4h_get_uid_pk(IN uint8_t *auth_key,
                           uint8_t key_no,
                           OUT uint8_t *uid);
```

Parameters

| | |
|--------------------|--|
| *auth_key | pointer to array contained AES key |
| auth_key_no | ordinal number of AES key into reader (0 - 15) |
| *uid | pointer to array contained UID |

[*nt4h_change_key*](#) [*nt4h_change_key_pk*](#)

Function description

Function changes AES key. Authentication with application master key is required.

Function declaration (C language)

```

UFR_STATUS nt4h_change_key_pk(IN uint8_t *auth_key,
                               uint8_t key_no,
                               IN uint8_t *new_key,
                               IN uint8_t *old_key);
UFR_STATUS DL_API nt4h_change_key(uint8_t auth_key_no,
                                   uint8_t key_no,
                                   IN uint8_t *new_key,
                                   IN uint8_t *old_key);

```

Parameters

| | |
|--------------------|--|
| *auth_key | pointer to array contained AES key |
| auth_key_no | ordinal number of AES key into reader (0 - 15) |
| key_no | key number 0 - 2 or 0 - 4 |
| *new_key | pointer to array contained new AES key |
| *old_key | pointer to array contained current AES key |

[*nt4h_get_sdm_ctr*](#)

[*nt4h_get_sdm_ctr_pk*](#)

[*nt4h_get_sdm_ctr_no_auth*](#)

Function description

Function supports retrieving of the current values of SDM reading counter.

Function declaration (C language)

```

UFR_STATUS nt4h_get_sdm_ctr_pk(IN uint8_t *auth_key,
                               uint8_t file_no,
                               uint8_t key_no,
                               VAR uint32_t *sdm_read_ctr);
UFR_STATUS nt4h_get_sdm_ctr(uint8_t auth_key_no,
                            uint8_t file_no,
                            uint8_t key_no,
                            VAR uint32_t *sdm_read_ctr);
UFR_STATUS nt4h_get_sdm_ctr_no_auth(uint8_t file_no,
                                     VAR uint32_t *sdm_read_ctr);

```

Parameters

| | |
|----------------------|--|
| *auth_key | pointer to array contained AES key |
| auth_key_no | ordinal number of AES key into reader (0 - 15) |
| file_no | file number of SDM file (2) |
| key_no | key number 0 - 2 or 0 - 4 |
| *sdm_read_ctr | pointer to value of SDM reading counter |

nt4h_check_sdm_mac

Function description

Helper function for the MAC of SDM checking. User need to know SDM counter, UID and AES key for file data read.

Function declaration (C language)

```
UFR_STATUS nt4h_check_sdm_mac(uint32_t smd_read_counter,
                              IN uint8_t *uid,
                              IN uint8_t *auth_key,
                              IN uint8_t *mac_in_data,
                              IN uint8_t mac_in_len,
                              IN uint8_t *sdm_mac);
```

Parameters

| | |
|-------------------------|---|
| smd_read_counter | value of SDM reading counter |
| *uid | pointer to array contained 7 bytes UID |
| *auth_key | pointer to array contained AES file data read key |
| *mac_in_data | data from mac_input_offset to mac_offset |
| mac_in_len | mac_input_offset - mac_offset |
| *sdm_mac | pointer to array contained 8 bytes SDM MAC |

nt4h_decrypt_sdm_enc_file_data

Function description

Helper function for decryption of encrypted file data. User need to know SDM counter, UID and AES key for file data read.

Function declaration (C language)

```
UFR_STATUS nt4h_decrypt_sdm_enc_file_data(uint32_t smd_read_counter,
                                           IN uint8_t *uid,
                                           IN uint8_t *auth_key,
                                           IN uint8_t *enc_file_data,
                                           IN uint8_t enc_file_data_len);
```

Parameters

| | |
|--------------------------|--|
| smd_read_counter | value of SDM reading counter |
| *uid | pointer to array contained 7 bytes UID |
| *auth_key | pointer to array contained AES file data read key |
| *enc_file_data | pointer to array contained encrypted part of file data |
| enc_file_data_len | length of encrypted part of file data |

nt4h_decrypt_picc_data

Function description

Helper function for decryption of encrypted PICC data. Function returns UID and SDM reading counter. User need to know AES key for metadata read (PICC data).

Function declaration (C language)

```
UFR_STATUS nt4h_decrypt_picc_data(IN uint8_t *picc_data,
                                  IN uint8_t *auth_key,
                                  IN uint8_t *picc_data_tag,
                                  IN uint8_t *uid,
                                  IN uint32_t *smd_read_cnt);
```

Parameters

| | |
|-----------------------|--|
| *picc_data | pointer to array contained encrypted PICC data |
| *auth_key | pointer to array contained AES meta data read key |
| *picc_data_tag | if bit 7 set exist UID mirroring if bit 6 set exist SDM reading counter |
| *uid | pointer to array contained 7 bytes UID |
| *smd_read_cnt | pointer to value of SDM reading counter |

Miscellaneous functions

CheckUidChangeable

Function description

Function tries to change UID on the card. On some cards (e.g. Magic Classic) changing UID is possible. If tested card is that type of card, then the function returns UFR_OK.

Function declaration (C language)

```
UFR_STATUS CheckUidChangeable(void);
```

ReaderRfReset

Function description

Function reset RF field at the reader. RF field will be off, and then on after 50ms.

Function declaration (C language)

```
UFR_STATUS ReaderRfReset(void);
```

GetReaderStatus

From library version 5.0.31 and firmware version 5.0.33

Function description

Function returns various reader states. The reader states are defined into following structures. This function is useful for check if reader still into emulation mode after calling TagEmulationStartRam() function.

```
typedef enum E_EMULATION_MODES {
    TAG_EMU_DISABLED,
    TAG_EMU_DEDICATED,
    TAG_EMU_COMBINED,
    TAG_EMU_AUTO_AD_HOC
}emul_modes_t;
```

```
typedef enum E_EMULATION_STATES
{
    EMULATION_NONE,
    EMULATION_IDLE,
    EMULATION_AUTO_COLL,
    EMULATION_ACTIVE,
    EMULATION_HALT,
    EMULATION_POWER_OFF
}emul_states_t;
```

```
typedef enum E_PCD_MGR_STATES
{
    PCD_MGR_NO_RF_GENERATED,
    PCD_MGR_14443A_POLLING,
    PCD_MGR_14443A_SELECTED,
    PCD_MGR_CE_DEDICATED,
    PCD_MGR_CE_COMBO_START,
    PCD_MGR_CE_COMBO,
    PCD_MGR_CE_COMBO_IN_FIELD
}pcd_states_t;
```

Function declaration (C language)

```

UFR_STATUS GetReaderStatus(pcd_states_t *state,
                           emul_modes_t *emul_mode,
                           emul_states_t *emul_state,
                           uint8_t *sleep_mode);

```

Parameters

| | |
|-------------------|---|
| state | - normal working mode states are PCD_MGR_NO_RF_GENERATED or PCD_MGR_14443A_POLLING or PCD_MGR_14443A_SELECTED. - NTAG emulation mode state is PCD_MGR_CE_DEDICATED |
| emul_mode | - normal working mode state is TAG_EMU_DISABLED - NTAG emulation mode state is TAG_EMU_DEDICATED |
| emul_state | state from structure emul_states_t |
| sleep_mode | 0 - reader is in normal or emulation mode 1 - reader is in sleep mode |

Appendix: STATUS CODES (DL_STATUS result)

| | |
|---|------|
| UFR_OK | 0x00 |
| UFR_COMMUNICATION_ERROR | 0x01 |
| UFR_CHKSUM_ERROR | 0x02 |
| UFR_READING_ERROR | 0x03 |
| UFR_WRITING_ERROR | 0x04 |
| UFR_BUFFER_OVERFLOW | 0x05 |
| UFR_MAX_ADDRESS_EXCEEDED | 0x06 |
| UFR_MAX_KEY_INDEX_EXCEEDED | 0x07 |
| UFR_NO_CARD | 0x08 |
| UFR_COMMAND_NOT_SUPPORTED | 0x09 |
| UFR_FORBIDEN_DIRECT_WRITE_IN_SECTOR_TRAILER | 0x0A |
| UFR_ADDRESSED_BLOCK_IS_NOT_SECTOR_TRAILER | 0x0B |
| UFR_WRONG_ADDRESS_MODE | 0x0C |
| UFR_WRONG_ACCESS_BITS_VALUES | 0x0D |
| UFR_AUTH_ERROR | 0x0E |
| UFR_PARAMETERS_ERROR | 0x0F |
| UFR_MAX_SIZE_EXCEEDED | 0x10 |
| UFR_UNSUPPORTED_CARD_TYPE | 0x11 |
| UFR_COUNTER_ERROR | 0x12 |
| UFR_WRITE_VERIFICATION_ERROR | 0x70 |
| UFR_BUFFER_SIZE_EXCEEDED | 0x71 |
| UFR_VALUE_BLOCK_INVALID | 0x72 |
| UFR_VALUE_BLOCK_ADDR_INVALID | 0x73 |
| UFR_VALUE_BLOCK_MANIPULATION_ERROR | 0x74 |
| UFR_WRONG_UI_MODE | 0x75 |
| UFR_KEYS_LOCKED | 0x76 |
| UFR_KEYS_UNLOCKED | 0x77 |
| UFR_WRONG_PASSWORD | 0x78 |

| | |
|------------------------------------|------|
| UFR_CAN_NOT_LOCK_DEVICE | 0x79 |
| UFR_CAN_NOT_UNLOCK_DEVICE | 0x7A |
| UFR_DEVICE_EEPROM_BUSY | 0x7B |
| UFR_RTC_SET_ERROR | 0x7C |
| ANTI_COLLISION_DISABLED | 0x7D |
| NO_TAGS_ENUMERATED | 0x7E |
| CARD_ALREADY_SELECTED | 0x7F |
| UFR_COMMUNICATION_BREAK | 0x50 |
| UFR_NO_MEMORY_ERROR | 0x51 |
| UFR_CAN_NOT_OPEN_READER | 0x52 |
| UFR_READER_NOT_SUPPORTED | 0x53 |
| UFR_READER_OPENING_ERROR | 0x54 |
| UFR_READER_PORT_NOT_OPENED | 0x55 |
| UFR_CANT_CLOSE_READER_PORT | 0x56 |
| UFR_FT_STATUS_ERROR_1 | 0xA0 |
| UFR_FT_STATUS_ERROR_2 | 0xA1 |
| UFR_FT_STATUS_ERROR_3 | 0xA2 |
| UFR_FT_STATUS_ERROR_4 | 0xA3 |
| UFR_FT_STATUS_ERROR_5 | 0xA4 |
| UFR_FT_STATUS_ERROR_6 | 0xA5 |
| UFR_FT_STATUS_ERROR_7 | 0xA6 |
| UFR_FT_STATUS_ERROR_8 | 0xA7 |
| UFR_FT_STATUS_ERROR_9 | 0xA8 |
| UFR_WRONG_NDEF_CARD_FORMAT | 0x80 |
| UFR_NDEF_MESSAGE_NOT_FOUND | 0x81 |
| UFR_NDEF_UNSUPPORTED_CARD_TYPE | 0x82 |
| UFR_NDEF_CARD_FORMAT_ERROR | 0x83 |
| UFR_MAD_NOT_ENABLED | 0x84 |
| UFR_MAD_VERSION_NOT_SUPPORTED | 0x85 |
| UFR_NDEF_MESSAGE_NOT_COMPATIBLE | 0x86 |
| FORBIDDEN_IN_TAG_EMULATION_MODE | 0x90 |
| UFR_MFP_COMMAND_OVERFLOW | 0xB0 |
| UFR_MFP_INVALID_MAC | 0xB1 |
| UFR_MFP_INVALID_BLOCK_NR | 0xB2 |
| UFR_MFP_NOT_EXIST_BLOCK_NR | 0xB3 |
| UFR_MFP_COND_OF_USE_ERROR | 0xB4 |
| UFR_MFP_LENGTH_ERROR | 0xB5 |
| UFR_MFP_GENERAL_MANIP_ERROR | 0xB6 |
| UFR_MFP_SWITCH_TO_ISO14443_4_ERROR | 0xB7 |
| UFR_MFP_ILLEGAL_STATUS_CODE | 0xB8 |
| UFR_MFP_MULTI_BLOCKS_READ | 0xB9 |
| NT4H_COMMAND_ABORTED | 0xC0 |
| NT4H_LENGTH_ERROR | 0xC1 |
| NT4H_PARAMETER_ERROR | 0xC2 |
| NT4H_NO_SUCH_KEY | 0xC3 |
| NT4H_PERMISSION_DENIED | 0xC4 |
| NT4H_AUTHENTICATION_DELAY | 0xC5 |

| | |
|--|------------|
| NT4H_MEMORY_ERROR | 0xC6 |
| NT4H_INTEGRITY_ERROR | 0xC7 |
| NT4H_FILE_NOT_FOUND | 0xC8 |
| NT4H_BOUNDARY_ERROR | 0xC9 |
| NT4H_INVALID_MAC | 0xCA |
| NT4H_NO_CHANGES | 0xCB |
| multiple units - return from the functions with ReaderList_ prefix in name | |
| UFR_DEVICE_WRONG_HANDLE | 0x100 |
| UFR_DEVICE_INDEX_OUT_OF_BOUND | 0x101 |
| UFR_DEVICE_ALREADY_OPENED | 0x102 |
| UFR_DEVICE_ALREADY_CLOSED | 0x103 |
| UFR_DEVICE_IS_NOT_CONNECTED | 0x104 |
| Originality check status codes: | |
| UFR_NOT_NXP_GENUINE | 0x200 |
| UFR_OPEN_SSL_DYNAMIC_LIB_FAILED | 0x201 |
| UFR_OPEN_SSL_DYNAMIC_LIB_NOT_FOUND | 0x202 |
| uFCoder library status codes: | |
| UFR_NOT_IMPLEMENTED | 0x1000 |
| UFR_COMMAND_FAILED | 0x1001 |
| UFR_TIMEOUT_ERR | 0x1002 |
| UFR_FILE_SYSTEM_ERROR | 0x1003 |
| UFR_FILE_SYSTEM_PATH_NOT_EXISTS | 0x1004 |
| UFR_FILE_NOT_EXISTS | 0x1005 |
| APDU status codes: | |
| UFR_APDU_TRANSCIEVE_ERROR | 0xAE |
| UFR_APDU_JC_APP_NOT_SELECTED | 0x6000 |
| UFR_APDU_JC_APP_BUFF_EMPTY | 0x6001 |
| UFR_APDU_WRONG_SELECT_RESPONSE | 0x6002 |
| UFR_APDU_WRONG_KEY_TYPE | 0x6003 |
| UFR_APDU_WRONG_KEY_SIZE | 0x6004 |
| UFR_APDU_WRONG_KEY_PARAMS | 0x6005 |
| UFR_APDU_WRONG_SIGNING_ALGORITHM | 0x6006 |
| UFR_APDU_PLAIN_TEXT_MAX_SIZE_EXCEEDED | 0x6007 |
| UFR_APDU_UNSUPPORTED_KEY_SIZE | 0x6008 |
| UFR_APDU_UNSUPPORTED_ALGORITHMS | 0x6009 |
| UFR_APDU_PKI_OBJECT_NOT_FOUND | 0x600A |
| UFR_APDU_MAX_PIN_LENGTH_EXCEEDED | 0x600B |
| UFR_DIGEST_LENGTH_DOES_NOT_MATCH | 0x600C |
| JCApp status codes: | |
| UFR_APDU_SW_TAG | 0x000A0000 |
| UFR_APDU_SW_OPERATION_IS_FAILED | 0x000A6300 |
| UFR_APDU_SW_WRONG_LENGTH | 0x000A6700 |
| UFR_APDU_SW_SECURITY_STATUS_NOT_SATISFIED | 0x000A6982 |
| UFR_APDU_SW_AUTHENTICATION_METHOD_BLOCKED | 0x000A6983 |
| UFR_APDU_SW_DATA_INVALID | 0x000A6984 |
| UFR_APDU_SW_CONDITIONS_NOT_SATISFIED | 0x000A6985 |
| UFR_APDU_SW_WRONG_DATA | 0x000A6A80 |
| UFR_APDU_SW_FILE_NOT_FOUND | 0x000A6A82 |

| | |
|--|------------|
| UFR_APDU_SW_RECORD_NOT_FOUND | 0x000A6A83 |
| UFR_APDU_SW_DATA_NOT_FOUND | 0x000A6A88 |
| UFR_APDU_SW_ENTITY_ALREADY_EXISTS | 0x000A6A89 |
| UFR_APDU_SW_INS_NOT_SUPPORTED | 0x000A6D00 |
| UFR_APDU_SW_NO_PRECISE_DIAGNOSTIC | 0x000A6F00 |
| Cryptographic subsystem status codes: | |
| CRYPTO_SUBSYS_NOT_INITIALIZED | 0x6101 |
| CRYPTO_SUBSYS_SIGNATURE_VERIFICATION_ERROR | 0x6102 |
| CRYPTO_SUBSYS_MAX_HASH_INPUT_EXCEEDED | 0x6103 |
| CRYPTO_SUBSYS_INVALID_HASH_ALGORITHM | 0x6104 |
| CRYPTO_SUBSYS_INVALID_CIPHER_ALGORITHM | 0x6105 |
| CRYPTO_SUBSYS_INVALID_PADDING_ALGORITHM | 0x6106 |
| CRYPTO_SUBSYS_WRONG_SIGNATURE | 0x6107 |
| CRYPTO_SUBSYS_WRONG_HASH_OUTPUT_LENGTH | 0x6108 |
| CRYPTO_SUBSYS_UNKNOWN_ECC_CURVE | 0x6109 |
| CRYPTO_SUBSYS_HASHING_ERROR | 0x610A |
| CRYPTO_SUBSYS_INVALID_SIGNATURE_PARAMS | 0x610B |
| CRYPTO_SUBSYS_INVALID_RSA_PUB_KEY | 0x610C |
| CRYPTO_SUBSYS_INVALID_ECC_PUB_KEY_PARAMS | 0x610D |
| CRYPTO_SUBSYS_INVALID_ECC_PUB_KEY | 0x610E |
| UFR_WRONG_PEM_CERT_FORMAT | 0x61C0 |
| X.509 status codes: | |
| X509_CAN_NOT_OPEN_FILE | 0x6200 |
| X509_WRONG_DATA | 0x6201 |
| X509_WRONG_LENGTH | 0x6202 |
| X509_UNSUPPORTED_PUBLIC_KEY_TYPE | 0x6203 |
| X509_UNSUPPORTED_PUBLIC_KEY_SIZE | 0x6204 |
| X509_UNSUPPORTED_PUBLIC_KEY_EXPONENT | 0x6205 |
| X509_EXTENSION_NOT_FOUND | 0x6206 |
| X509_WRONG_SIGNATURE | 0x6207 |
| X509_UNKNOWN_PUBLIC_KEY_TYPE | 0x6208 |
| X509_WRONG_RSA_PUBLIC_KEY_FORMAT | 0x6209 |
| X509_WRONG_ECC_PUBLIC_KEY_FORMAT | 0x620A |
| X509_SIGNATURE_NOT_MATCH_CA_PUBLIC_KEY | 0x620B |
| X509_UNSUPPORTED_SIGNATURE_SCH | 0x620C |
| X509_UNSUPPORTED_ECC_CURVE | 0x620D |
| PKCS#7 status codes: | |
| PKCS7_WRONG_DATA | 0x6241 |
| PKCS7_UNSUPPORTED_SIGNATURE_SCHEME | 0x6242 |
| PKCS7_SIG_SCH_NOT_MATCH_CERT_KEY_TYPE | 0x6243 |
| PKCS7_WRONG_SIGNATURE | 0x6247 |
| MRTD status codes: | |
| MRTD_SECURE_CHANNEL_SESSION_FAILED | 0x6280 |
| MRTD_WRONG_SOD_DATA | 0x6281 |
| MRTD_WRONG_SOD_LENGTH | 0x6282 |
| MRTD_UNKNOWN_DIGEST_ALGORITHM | 0x6283 |
| MRTD_WARNING_DOES_NOT_CONTAINS_DS_CERT | 0x6284 |
| MRTD_DATA_GROUOP_INDEX_NOT_EXIST | 0x6285 |

| | |
|--------------------------------------|--------|
| MRTD_EF_COM_WRONG_DATA | 0x6286 |
| MRTD_EF_DG_WRONG_DATA | 0x6287 |
| MRTD_EF_DG1_WRONG_LDS_VERSION_LENGTH | 0x6288 |
| MRTD_VERIFY_CSCA_NOT_EXIST | 0x6289 |
| MRTD_VERIFY_WRONG_DS_SIGNATURE | 0x628A |
| MRTD_VERIFY_WRONG_CSCA_SIGNATURE | 0x628B |
| MRTD_MRZ_CHECK_ERROR | 0x628C |
| ICAO Master List status codes: | |
| ICAO_ML_WRONG_FORMAT | 0x6300 |
| ICAO_ML_CAN_NOT_OPEN_FILE | 0x6301 |
| ICAO_ML_CAN_NOT_READ_FILE | 0x6302 |
| ICAO_ML_CERTIFICATE_NOT_FOUND | 0x6303 |
| ICAO_ML_WRONG_SIGNATURE | 0x6307 |

DESFIRE Card Status Codes:

| | |
|-----------------------------------|--------|
| READER_ERROR | 2999 |
| NO_CARD_DETECTED | 3000 |
| CARD_OPERATION_OK | 3001 |
| WRONG_KEY_TYPE | 3002 |
| KEY_AUTH_ERROR | 3003 |
| CARD_CRYPTO_ERROR | 3004 |
| READER_CARD_COMM_ERROR | 3005 |
| PC_READER_COMM_ERROR | 3006 |
| COMMIT_TRANSACTION_NO_REPLY | 3007 |
| COMMIT_TRANSACTION_ERROR | 3008 |
| | |
| DESFIRE_CARD_NO_CHANGES | 0x0C0C |
| DESFIRE_CARD_OUT_OF_EEPROM_ERROR | 0x0C0E |
| DESFIRE_CARD_ILLEGAL_COMMAND_CODE | 0x0C1C |
| DESFIRE_CARD_INTEGRITY_ERROR | 0x0C1E |
| DESFIRE_CARD_NO_SUCH_KEY | 0x0C40 |
| DESFIRE_CARD_LENGTH_ERROR | 0x0C7E |
| DESFIRE_CARD_PERMISSION_DENIED | 0x0C9D |
| DESFIRE_CARD_PARAMETER_ERROR | 0x0C9E |

| | |
|------------------------------------|--------|
| DESFIRE_CARD_APPLICATION_NOT_FOUND | 0x0CA0 |
| DESFIRE_CARD_APPL_INTEGRITY_ERROR | 0x0CA1 |
| DESFIRE_CARD_AUTHENTICATION_ERROR | 0x0CAE |
| DESFIRE_CARD_ADDITIONAL_FRAME | 0x0CAF |
| DESFIRE_CARD_BOUNDARY_ERROR | 0x0CBE |
| DESFIRE_CARD_PICC_INTEGRITY_ERROR | 0x0CC1 |
| DESFIRE_CARD_COMMAND_ABORTED | 0x0CCA |
| DESFIRE_CARD_PICC_DISABLED_ERROR | 0x0CCD |
| DESFIRE_CARD_COUNT_ERROR | 0x0CCE |
| DESFIRE_CARD_DUPLICATE_ERROR | 0x0CDE |
| DESFIRE_CARD_EEPROM_ERROR_DES | 0x0CEE |
| DESFIRE_CARD_FILE_NOT_FOUND | 0x0CF0 |
| DESFIRE_CARD_FILE_INTEGRITY_ERROR | 0x0CF1 |

Appendix: DLogic CardType enumeration

| | |
|-----------------------------|------|
| TAG_UNKNOWN | 0x00 |
| DL_MIFARE_ULTRALIGHT | 0x01 |
| DL_MIFARE_ULTRALIGHT_EV1_11 | 0x02 |
| DL_MIFARE_ULTRALIGHT_EV1_21 | 0x03 |
| DL_MIFARE_ULTRALIGHT_C | 0x04 |
| DL_NTAG_203 | 0x05 |
| DL_NTAG_210 | 0x06 |
| DL_NTAG_212 | 0x07 |
| DL_NTAG_213 | 0x08 |
| DL_NTAG_215 | 0x09 |
| DL_NTAG_216 | 0x0A |
| DL_MIKRON_MIK640D | 0x0B |
| NFC_T2T_GENERIC | 0x0C |
| DL_NT3H_1101 | 0x0D |
| DL_NT3H_1201 | 0x0E |
| DL_NT3H_2111 | 0x0F |
| DL_NT3H_2211 | 0x10 |
| DL_NTAG_413_DNA | 0x11 |
| DL_NTAG_424_DNA | 0x12 |
| | |
| DL_MIFARE_MINI | 0x20 |
| DL_MIFARE_CLASSIC_1K | 0x21 |
| DL_MIFARE_CLASSIC_4K | 0x22 |
| DL_MIFARE_PLUS_S_2K | 0x23 |
| DL_MIFARE_PLUS_S_4K | 0x24 |
| DL_MIFARE_PLUS_X_2K | 0x25 |
| DL_MIFARE_PLUS_X_4K | 0x26 |
| DL_MIFARE_PLUS_S_2K_SL0 | 0x23 |
| DL_MIFARE_PLUS_S_4K_SL0 | 0x24 |
| DL_MIFARE_PLUS_X_2K_SL0 | 0x25 |
| DL_MIFARE_PLUS_X_4K_SL0 | 0x26 |
| DL_MIFARE_DESFIRE | 0x27 |
| DL_MIFARE_DESFIRE_EV1_2K | 0x28 |
| DL_MIFARE_DESFIRE_EV1_4K | 0x29 |
| DL_MIFARE_DESFIRE_EV1_8K | 0x2A |
| DL_MIFARE_DESFIRE_EV2_2K | 0x2B |
| DL_MIFARE_DESFIRE_EV2_4K | 0x2C |
| DL_MIFARE_DESFIRE_EV2_8K | 0x2D |
| DL_MIFARE_PLUS_S_2K_SL1 | 0x2E |
| DL_MIFARE_PLUS_X_2K_SL1 | 0x2F |
| DL_MIFARE_PLUS_EV1_2K_SL1 | 0x30 |
| DL_MIFARE_PLUS_X_2K_SL2 | 0x31 |
| DL_MIFARE_PLUS_S_2K_SL3 | 0x32 |
| DL_MIFARE_PLUS_X_2K_SL3 | 0x33 |
| DL_MIFARE_PLUS_EV1_2K_SL3 | 0x34 |
| DL_MIFARE_PLUS_S_4K_SL1 | 0x35 |

| | |
|------------------------------|------|
| DL_MIFARE_PLUS_X_4K_SL1 | 0x36 |
| DL_MIFARE_PLUS_EV1_4K_SL1 | 0x37 |
| DL_MIFARE_PLUS_X_4K_SL2 | 0x38 |
| DL_MIFARE_PLUS_S_4K_SL3 | 0x39 |
| DL_MIFARE_PLUS_X_4K_SL3 | 0x3A |
| DL_MIFARE_PLUS_EV1_4K_SL3 | 0x3B |
| DL_MIFARE_PLUS_SE_SL0 | 0x3C |
| DL_MIFARE_PLUS_SE_SL1 | 0x3D |
| DL_MIFARE_PLUS_SE_SL2 | 0x3E |
| DL_MIFARE_DESFIRE_LIGHT | 0x3F |
| | |
| DL_GENERIC_ISO14443_4 | 0x40 |
| DL_GENERIC_ISO14443_TYPE_B | 0x41 |
| DL_GENERIC_ISO14443_4_TYPE_B | 0x41 |
| DL_GENERIC_ISO14443_3_TYPE_B | 0x42 |
| | |
| DL_IMEI_UID | 0x80 |

Appendix: DLogic reader type enumeration

| Value | Reader name |
|------------|------------------------------------|
| 0xD1150021 | μFR Classic |
| 0xD2150021 | μFR Advance |
| 0xD3150021 | μFR PRO |
| | |
| 0xD1180022 | μFR Nano Classic |
| 0xD3180022 | μFR Nano PRO |
| | |
| 0xD1190222 | μFR Nano Classic RS232 |
| 0xD3190222 | μFR Nano PRO RS232 |
| | |
| 0xD11A0022 | μFR Classic Card Size |
| 0xD21A0022 | μFR Advance Card Size |
| 0xD31A0022 | μFR PRO Card Size |
| | |
| 0xD11A0222 | μFR Classic Card Size RS232 |
| 0xD21A0222 | μFR Advance Card Size RS232 |
| 0xD31A0222 | μFR PRO Card Size RS232 |
| | |
| 0xD11B0022 | μFR Classic Card Size RF-AMP |
| 0xD21B0022 | μFR Advance Card Size RF-AMP |
| 0xD31B0022 | μFR PRO Card Size RF-AMP |
| | |
| 0xD11B0222 | μFR Classic Card Size RS232 RF-AMP |
| 0xD21B0222 | μFR Advance Card Size RS232 RF-AMP |
| 0xD31B0222 | μFR PRO Card Size RS232 RF-AMP |
| | |
| 0xD1380022 | uFR Nano Plus |
| 0xD3380022 | uFR Nano PRO Plus |
| | |
| 0xD1390022 | uFR Nano RS232 Plus |
| | |
| 0xD23A0022 | uFR Classic Card Size Plus |
| 0xD33A0022 | uFR Classic Card Size PRO Plus |

| | |
|------------|--|
| | |
| 0xD23A0222 | uFR Classic Card Size RS232 Plus |
| | |
| 0xD23B0022 | uFR Classic Card Size Plus with RF Booster |
| 0xD33B0022 | uFR Classic Card Size PRO Plus with RF Booster |
| | |
| 0xD33B0222 | uFR Classic Card Size RS232 Plus with RF Booster |
| | |

Appendix: FTDI troubleshooting

On Windows systems, it is pretty straightforward with .msi installer executable.

On Linux platforms, few more things must be provided:

- Appropriate user permissions on FTDI and uFCoder libraries
- “ftdi_sio” and helper module “usbserial” must be removed/unloaded for proper functioning. Each time device is plugged in, Linux kernel loads appropriate module. So, each time device is plugged, you must issue following command in CLI:
`sudo rmmod ftdi_sio usbserial`
- This can be painful, so good practice is to blacklist these two modules in “etc/modprobe.d/” directory. Create new file called “ftdi.conf” and add following line :

```
#disable auto load FTDI modules - D-LOGIC
blacklist ftdi_sio
blacklist usbserial
```

On macOS, it is good enough to follow FTDI’s guidelines for proper driver installation.

Update: since Mac OS version 10.11 El Capitan, macOS introduces SIP (System Integration Protection) which does not allow user to write into system directories like ‘usr/lib’ and similar, which makes a lot of problems in implementation. For that purpose, ‘libuFCoder.dylib’ library embeds FTDI’s library too, so there is no need for installation of FTDI’s drivers.

Previous macOS versions works fine with FTDI’s D2XX drivers.

D2XX drivers links: <http://www.ftdichip.com/Drivers/D2XX.htm>

Direct link to current drivers: <http://www.ftdichip.com/Drivers/D2XX/MacOSX/D2XX1.2.2.dmg>

Install instructions are located in the archive. You need to install/copy needed drivers.

Other kernel extensions problems:

To successfully open the FTDI port, it is necessary to check if another FTDI module (kernel extension) is loaded, and if it is, it needs to be deactivated.

Procedure:

1. plug-in FTDI device (uFReader) and wait a few seconds
2. open console
3. you can check if device is detected:

```
$ sudo dmesg
```

```
FTDIUSBSerialDriver:          0  **4036001** start - ok
```

4. check if kernel extension is loaded for FTDI:

```
$ kextstat | grep -i ftdi
```

```

94 0 0xffffffff7f82041000 0x8000 0x8000
**com.FTDI.driver.FTDIUSBSerialDriver** (2.2.18) <70 34 5 4 3 1>

```

5. you need to deactivate it - eject it from memory

```
sudo kextunload /System/Library/Extensions/FTDIUSBSerialDriver.kext
```

Remark - with the system OS X 10.11 (El Capitan)

After the module is removed, it returns again. It is necessary to download the Helper from FTDI site and to run it on the machine, and after that restart is required.

Information from site:

If using a device with standard FTDI vendor and product identifiers, install D2xxHelper to prevent OS X 10.11 (El Capitan) claiming the device as a serial port (locking out D2XX programs).

This is how to load driver on El Capitan:

```

$ kextstat | grep -i ftd 146 0 0xffffffff7f82d99000 0x7000 0x7000
com.apple.driver.AppleUSBFTDI (5.0.0) D853EEF2-435D-370E-AFE3-DE49CA29DF47 <123 38 5 4
3 1>

$ sudo kextunload /System/Library/Extensions/AppleUSBFTDI.kext

```

After this, FTDI devices are ready to work with FTD2XX libraries.

From library version 5.0.28. Mac OS support

Mac OS 10.14 (Mojave).

USB serial works if device opened with ReaderOpenEx with virtual com port option without unload /System/Library/Extension/AppleUSBFTDI.kext . Com port name is /dev/tty.usbserial-xxxxxxx.

Mac OS 10.15 (Catalina).

USB serial and FTD2xx works without unload /System/Library/DriverExtensstons/DriverKit.AppleUSBFTDI.dext.

Appendix: Change log

Firmware version 5.0.1 and later apply only to uFR PLUS devices

| Date | Description | API revision | refers to the lib version / firmware ver. |
|------------|---|--------------|---|
| 2020-02-18 | New function explained: SetISO14443_4_Mode_GetATS() Use to get tag ATS acquired on selection process. | 2.25 | 5.0.32 / 5.0.34 |
| 2020-02-13 | NTAG emulation into RAM (1024 bytes 256 pages) GetReaderStatus | 2.24 | 5.0.31 / 5.0.33 |

| | | | |
|------------|---|------|-----------------------------|
| 2020-01-31 | NT4H (NTAG 4xx DNA) support. Desfire light support. DesfireClearRecorFile functions bug fix. | 2.23 | 5.0.29 / 5.0.32 |
| 2020-01-23 | Custom baud rate support. Mac OS USB serial support. | 2.22 | 5.0.28 / 5.0.31 |
| 2020-01-10 | Added description of a new helper function for Machine Readable Travel Documents (MRTD) support, MRTD_MRZSubjacentCheck(). Added new status code: MRTD_MRZ_CHECK_ERROR. | 2.21 | 5.0.26 / 5.0.22 |
| 2019-12-17 | Added general purpose cryptographic functions for hashing and digital signature verification. Updated Machine Readable Travel Documents (MRTD) support. Updated status codes (X.509, PKCS#7, MRTD and ICAO ML status codes). Updated Tag Emulation mode and WriteEmulationNDEF description (maximum NDEF size for emulation). | 2.20 | 5.0.25 / 5.0.22 |
| 2019-12-09 | Added EspSetTransparentReader function for uFR Online. | 2.19 | 5.0.24 / uFR Online: 2.2.1 |
| 2019-11-14 | Added ReaderOpen_uFROnline function which opens communication with uFR Online device by serial number. ReaderOpen and ReaderOpenEx functions are also extended. | 2.18 | 5.0.23 / uFR Online: 2.1.6W |
| 2019-10-29 | Using Mifare Classic functions for Mifare Plus card in SL3 with AES key which calculated from Crypto1 key | 2.17 | 5.0.19/5.0.29 |
| 2019-09-26 | SAM support | 2.16 | 5.0.16/5.100.27 |
| 2019-08-28 | Machine Readable Travel Documents (MRTD) support | 2.15 | 5.0.12/5.0.22 |
| 2019-08-09 | Desfire records support | 2.14 | 5.0.14/5.0.25 |
| 2019-08-06 | Desfire DES, 2K3DES, and 3K3DES keys support | 2.13 | 5.0.14/5.0.25 |
| 2019-07-18 | ESP IO control added. Android support. | 2.11 | |
| 2019-05-21 | DLStorage JCAApp support | 2.10 | 5.0.8 / 5.0.20 |
| 2019-05-21 | In the JCAAppSelectByAid() function description added guidelines for the DLStorage JCAApp selection procedure. | 2.10 | 5.0.8 / 5.0.20 |
| 2019-05-21 | DLSigner JCAApp AID has been changed to a valid one 'F0 44 4C 6F 67 69 63 01 01' in the whole document. | 2.10 | 5.0.1 / 5.0.7 |
| 2019-05-21 | Updated uFCoder library error codes, APDU Error | 2.10 | 5.0.1 / 5.0.1 |

| | | | |
|------------|---|------|----------------|
| | Codes and JCAApp error codes. | | |
| 2019-05-21 | Common JCAApp PIN functions explained | 2.10 | 5.0.1 / 5.0.1 |
| 2019-05-21 | Java Card Application (JCAApp) explained | 2.10 | 5.0.1 / 5.0.1 |
| 2019-05-16 | Desfire get Application IDs added | 2.9 | 5.0.7 / 5.0.19 |
| 2018-12-14 | UfrRgbLightControl for classic devices only | 2.8 | 4.4.6 / 5.0.11 |
| 2018-11-20 | Additional settings in ReaderOpenEx() Supported communication via TCP/IP | 2.7 | 4.4.2 / 5.0.1 |
| 2018-11-05 | Supported communication via UDP | 2.6 | 4.4.1 / 5.0.1 |
| 2018-10-01 | Anti-collision support (multi card reader mode) added | 2.5 | 4.3.13 / 5.0.1 |
| 2018-09-05 | Functions for Mifare Ultralight C card for uFR PLUS devices only | 2.4 | 4.3.13 / 5.0.1 |
| 2018-07-02 | APDU functions for switching between ISO14443-4 and ISO7816 for uFR PLUS devices with SAM option only | 2.3 | |
| 2018-06-18 | Support for ISO7816 protocol for uFR PLUS devices with SAM option only | 2.2 | |
| 2018-06-18 | Functions for Mifare Plus card (AES encryption in reader) for uFR PLUS devices only | 2.2 | |
| 2018-05-29 | PKI infrastructure and digital signature support | 2.1 | 4.3.8 / 3.9.55 |